KARL J. KRAMER (CA SBN 136433)
ERIKA L. YAWGER (CA SBN 234919)
LAURA R. MASON (CA 252251)
MORRISON & FOERSTER LLP
755 Page Mill Road
Palo Alto, California 94304-1018
Telephone: (650) 813-5600
Facsimile: (650) 494-0792
KKramer@mofo.com

Attorneys for Plaintiff
SYNAPTICS INCORPORATED

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

SYNAPTICS INCORPORATED, a Delaware corporation, Plaintiff, v. ELANTECH DEVICES CORP., a corporation existing under the laws of Taiwan, R.O.C., Defendant.	Case No. CV 07 6434 CRB **JOINT CLAIM CONSTRUCTION AND PREHEARING STATEMENT**

The parties to the above-entitled action, Plaintiff Synaptics, Inc. ("Synaptics") and Defendant Elantech Devices Corporation ("Elantech"), respectfully submit this Joint Claim Construction and Prehearing Statement pursuant to Patent Local Rule 4-3.

Patent Local Rule 4-3(a)

Attached hereto as Exhibit A is a table setting forth the construction of those claim terms, phrases, or clauses in the patents at issue on which the parties agree, as well as each party's proposed construction of each disputed claim term, phrase, or clause in the patents at issue. The agreed-upon definitions in the attached chart include a single definition that spans both columns signifying each party's position. The parties will continue to meet and confer to narrow the issues for the claim construction briefing.

Patent Local Rule 4-3(b)

Attached hereto as Exhibit B is an identification of any intrinsic or extrinsic evidence on which Elantech currently intends to rely either in support of its own proposed construction or in opposition to Synaptics' proposed construction.

Attached hereto as Exhibit C is an identification of any intrinsic or extrinsic evidence on which Synaptics currently intends to rely either in support of its own proposed construction or in opposition to Elantech's proposed construction.

Patent Local Rule 4-3(c)

The parties anticipate that the length of time necessary for the Claim Construction Hearing is three hours. The parties will be prepared to complete the tutorial session with an hour or less per side.

Patent Local Rule 4-3(d)

At present, the parties believe that any expert testimony concerning claim construction that the Court may wish to consider is most easily submitted in the form of declarations in support of or in opposition to the briefing on claim construction.[1] However, Synaptics and Elantech reserve the right to call Dr. Andrew Wolfe and Dr. Ian Scott MacKenzie as witnesses at the Claim

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[1] The parties additionally have agreed that no additional expert depositions are necessary.

Construction Hearing in the event that such testimony is needed to clarify points raised in the briefing or in response to questions that the Court may wish to raise in connection with claim construction. Dr. Wolfe and Dr. MacKenzie have each provided two expert reports in connection with claim construction pursuant to the parties' agreement to exchange such reports. Those reports, served on July 14 and 30, 2008 are attached without exhibits, so as not to burden the court, as Exhibits D (Dr. Wolfe) and E (Dr. MacKenzie).

Patent Local Rule 4-3(e)

The parties have set a briefing schedule for the claim construction hearing as follows:

- Opening Claim Construction Briefs For Each Patentee: September 19, 2008
- Responsive Claim Construction Briefs For Each Defendant: October 3, 2008
- Reply Claim Construction Briefs For Each Patentee: October 10, 2008

The tutorial for the Court is set for October 21, 2008, at 2:00 p.m. The hearing on claim construction is set for October 23, 2008 at 2:00 p.m. Since no date has been previously set, the parties propose that a short prehearing conference be scheduled on October 21, 2008 after the tutorial.

Dated: August 8, 2008

KARL J. KRAMER
ERIKA L. YAWGER
LAURA R. MASON
MORRISON & FOERSTER LLP

By: /s/ Karl J. Kramer
Karl J. Kramer

Attorneys for Plaintiff Synaptics, Inc.

Dated: August 8, 2008

YITAI HU
SEAN P. DEBRUINE
ELIZABETH H. RADER
ALSTON + BIRD LLP

By: /s/ Sean P. DeBruine
Sean P. DeBruine

Attorneys for Defendant Elantech Devices Corp.

I, KARL J. KRAMER, am the ECF User whose ID and password are being used to file this JOINT CLAIM CONSTRUCTION AND PREHEARING STATEMENT. In compliance with General Order 45, X.B., I hereby attest that Sean P. DeBruine has concurred in this filing.

Dated: August 8, 2008

MORRISON & FOERSTER LLP

By: /s/ Karl J. Kramer
Karl J. Kramer

Attorneys for Plaintiff Synaptics, Inc.

EXHIBIT B

ELANTECH'S PROPOSED CLAIM CONSTRUCTION OF '978 PATENT AND IDENTIFICATION OF INTRINSIC AND EXTRINSIC EVIDENCE

Claim Term	Elantech's Proposed Construction	Intrinsic and Extrinsic Evidence
1. "gesture"	Elantech does not believe this term should be construed alone, but should be construed as part of a larger phrase in which it is recited. See below. To the extent "gesture" is construed alone, Elantech believes it should mean: *movement of a finger or object, either on a surface or in the air*	To the extent "gesture" is construed alone, Elantech relies on the following in intrinsic and extrinsic evidence: <u>Intrinsic Evidence</u>: FIGS. 1-21 and corresponding text including *e.g.*, 12:60-14:63 <u>Extrinsic Evidence</u>: Rebuttal Expert Report of Dr. Ian Scott MacKenzie Regarding Claim Construction of '978 Patent ("Dr. MacKenzie Rebuttal Report") at ¶ 13.
2. "capacitance profile(s)"	Elantech does not believe this term should be construed alone, but should be construed as part of a larger phrase in which it is recited. See below. To the extent "capacitance profile(s)" is construed alone, Elantech believes it should mean: *a complete set of capacitance measurements in an X or Y direction*	To the extent "capacitance profile(s)" is construed alone, Elantech relies on the following intrinsic and extrinsic evidence: <u>Intrinsic Evidence</u>: FIGS. 1-21 and corresponding text including, *e.g.*, 6:54-60; 7:3-5; 12:29-34; 47:7 <u>Extrinsic Evidence</u>: Expert Report of Dr. Ian Scott MacKenzie Regarding Claim Construction of '978 Patent ("Dr. MacKenzie Report") at ¶¶ 10-12; Dr. MacKenzie Rebuttal Report at ¶¶ 14-16.
3. "developing capacitance profiles" "develop a first capacitance profile"	"simultaneously measuring/measure the capacitance on all sensor traces in an X direction or a Y direction"	Elantech relies on the following intrinsic and extrinsic evidence: <u>Intrinsic Evidence</u>: FIGS. 1-21 and corresponding text including *e.g.*, 3:47-4:6; 4:10-14; 4:55-60; 5:49-53; 6:49-7:5;

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"develop at least one capacitance profile" "develop a second capacitive profile"		12:27-28; 12:35-59; 13:42-61 <u>Extrinsic Evidence</u>: Dr. MacKenzie Report at ¶¶ 10-12; Dr. MacKenzie Rebuttal Report at ¶¶ 17-20.
4. "identifying a simultaneous presence of at least two user input objects"	"recognizing a second-finger tap"	Elantech relies on the following intrinsic and extrinsic evidence: <u>Intrinsic Evidence</u>: FIGS. 1-21 and corresponding text including *e.g.*, 7:13-17; 46:46-48; 46:57-58; 46:46-63; 46:46-49:67; 47:66-48:1 <u>Extrinsic Evidence</u>: Dr. MacKenzie Report at ¶¶ 13-15; Dr. MacKenzie Rebuttal Report at ¶¶ 21-25.
5. "examining said capacitance profiles to determine an occurrence of a single gesture" "examine said first capacitance profile to determine an occurrence of a single gesture" "examine at least one capacitance profile to determine an occurrence of a single gesture"	"computing/compute the centroid (i.e., X, Y position) and pressure (i.e., Z value) information and comparing/compare (X, Y, Z) values to recognize a second-finger tap"	Elantech relies on the following intrinsic and extrinsic evidence: <u>Intrinsic Evidence</u>: FIGS. 1-21 and corresponding text including *e.g.*, 7:6-12; 12:31-34; 47:3-49:67 <u>Extrinsic Evidence</u>: Dr. MacKenzie Report at ¶¶ 16-17; Dr. MacKenzie Rebuttal Report at ¶¶ 26-28.
6. "single gesture resulting from the simultaneous presence of the at least two user input objects"	"a second finger tap (i.e., a two-finger gesture in which one finger remains resting on the pad while another finger taps to one side of the primary finger)"	<u>Intrinsic Evidence</u>: FIGS. 1-21 and corresponding text including *e.g.*, 7:13-17; 46:46-48; 46:57-58; 46:46-63; 46:46-49:67; 47:66-48:1

"single gesture resulting from the simultaneous proximity of at least two user input objects" "single gesture resulting from the simultaneous proximity of at least two input objects"		Extrinsic Evidence: Dr. MacKenzie Report at ¶ 13-18; Dr. MacKenzie Rebuttal Report at ¶¶ 29-30.
7. "indicating the occurrence of said single gesture" "indicate the occurrence of said single gesture"	"indicating the occurrence of a second-finger tap"	Elantech relies on the following intrinsic and extrinsic evidence: Intrinsic Evidence: FIGS. 1-21 and corresponding text including *e.g.*, 7:13-17; 46:46-48; 46:57-58; 46:46-63; 46:46-49:67; 47:21-23; 47:39-40; 47:66-48:1 Extrinsic Evidence: Dr. MacKenzie Report at ¶ 20; Dr. MacKenzie Rebuttal Report at ¶¶ 31-32.
8. "signal representing a simulated mouse button click" "signal representing a simulated mouse action" "simulated mouse action"	"a value of LEFT or RIGHT denoting a second finger tap"	Elantech relies on the following intrinsic and extrinsic evidence: Intrinsic Evidence: FIGS. 1-21 and corresponding text including *e.g.*, 7:13-17; 46:46-48; 46:57-58; 46:46-63; 46:46-49:67; 47:21-23; 47:39-40; 47:66-48:1 Extrinsic Evidence: Dr. MacKenzie Report at ¶¶ 21-22; Dr. MacKenzie Rebuttal Report at ¶ 33.
9. "developing capacitance profiles in both said X and Y	"simultaneously measuring the capacitance on all sensor traces individually in both an X direction and a Y direction"	Elantech relies on the following intrinsic and extrinsic evidence: Intrinsic Evidence:

directionws"		FIGS. 1-21 and corresponding text including *e.g.*, 3:47-4:6; 4:10-14; 4:55-60; 5:49-53; 6:49-7:5; 12:27-28; 12:35-59; 13:42-61 Extrinsic Evidence: Dr. MacKenzie Report at ¶¶ 10-12; Dr. MacKenzie Rebuttal Report at ¶¶ 14-20, 35.
10. "capacitive sensor"	Elantech believes no construction is necessary. To the extent any construction is given to this term, it simply means a sensor that senses capacitance.	Elantech relies on the following extrinsic evidence: Extrinsic Evidence: Dr. MacKenzie Rebuttal Report at ¶ 36.
11. "sensing circuitry"	Elantech believes no construction is necessary.	
12. "configured to generate outputs based on the capacitance"	Elantech believes no construction is necessary.	
13. "button press"	Elantech believes no construction is necessary.	
14. "simultaneous presence" "simultaneous proximity"	Elantech does not believe this term should be construed alone, but should be construed as part of a larger phrase. See above.	
15. "simulated mouse button click"	Elantech does not believe this term should be construed alone, but should be construed as part of a larger phrase. See above.	
16. "simulated mouse action"	Elantech does not believe this term should be construed alone, but should be construed as part of a larger phrase. See above.	

EXHIBIT D

KARL J. KRAMER (CA SBN 136433)
ERIKA L. YAWGER (CA SBN 234919)
LAURA R. MASON (CA SBN 252251)
MORRISON & FOERSTER LLP
755 Page Mill Road
Palo Alto, California 94304-1018
Telephone: (650) 813-5600
Facsimile: (650) 494-0792
kkramer@mofo.com

Attorneys for Plaintiffs
SYNAPTICS INCORPORATED

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

SYNAPTICS INCORPORATED, a Delaware corporation, Plaintiff, v. ELANTECH DEVICES CORPORATION, a corporation existing under the laws of Taiwan, R.O.C., Defendants.	Case No. CV07-6434 CRB **EXPERT REPORT OF ANDREW WOLFE Ph.D. CONCERNING CLAIM CONSTRUCTION FOR U.S. PATENT NO. 7,109,978**

I. BACKGROUND AND QUALIFICATIONS.

A. Education and Professional Experience.

1. I received a B.S.E.E. degree in Electrical Engineering and Computer Science from The Johns Hopkins University in 1985, an M.S. degree in Electrical and Computer Engineering from Carnegie Mellon University in 1987, and a Ph.D degree in Computer Engineering from Carnegie Mellon University in 1992. I was a visiting Assistant Professor at Carnegie Mellon University in 1992 and an Assistant Professor in the Electrical Engineering Department of Princeton University from 1991 to 1997. From 1999 to 2002, I served as a Consulting Professor at Stanford University, where I taught courses in computer architecture and microprocessor design. Attached to this Declaration as Exhibit 1 is a true and correct copy of my curriculum vitae.

2. I have been an active participant in the development of touch sensor technologies for over 20 years. From 1983 to 1985, I was a Senior Design Engineer at Touch Technology, Inc. in Annapolis, Maryland. In 1986 and 1987, I was a contractor at Carroll Touch Division, AMP Inc., in Round Rock, Texas, where I designed technologies for touch-screen systems. In 1989, I founded and developed technologies for The Graphics Technology Company, Inc., which developed touch-sensitive components and systems for PDA ("personal digital assistant") and other interactive systems. I worked at The Graphics Technology Company, Inc. on touch-sensor technology development from 1989 through 1995. From 1997 through 2002, I served in varying capacities, including Director of Technology and Chief Technical Officer, for SONICblue, Inc., a leading networked consumer electronics company. I also co-founded and served as Chief Technical Officer for RGB Inc., where in 2003 I developed architectural specifications for programmable video signal processors and other devices. Since 2002 I have also consulted for a number of companies on a range of technology development, investment, and intellectual property matters.

3. I am a named inventor on numerous patents relating to electrical and computer engineering. In particular, I am the named inventor on at least four patents relevant to touch-sensitive interfacing devices such as those at issue in this litigation: U.S. Patent Nos. 5,041,701; 5,438,168; 5,736,688; and 6,037,930.

4. I have an intimate knowledge of the state of touchpad technology development during the 1990's and can accurately reflect the state of that development from my own work experience. I have specific experience in the design of touch-sensor systems. I have supervised other engineers in the development of touch-sensor systems. I have studied and am familiar with the circuit and software design concepts utilized in the inventions claimed in the U.S. Patent No. 7,109,978, ("the '978 Patent") which is asserted in this litigation.

5. A list of publications that I have authored within the preceding ten years is attached as Exhibit 2. A listing of any other cases in which I have testified as an expert at trial or by deposition within the preceding four years is attached as Exhibit 3.

6. With a broad knowledge of touchpad technology, with a solid grounding in pertinent circuit and software design, with a historical perspective based on active personal participation, and with experience with the patent process, I believe that I am qualified to provide an accurate assessment of the technical issues in this case.

B. Summary of Task.

7. I was asked to review materials and provide technical teaching and opinions regarding the patents that the parties are asserting in this case. In this Report, I present an explanation of the historical and technical background for the technology at issue in this case, including an explanation of the state of the relevant art in 1992 (the time that the original patent application leading to the patent-in-suit was first filed). Also included in this Report is an explanation concerning the technical concepts and terms relevant to the interpretation of some of the claim limitations at issue. The documents that I reviewed and relied upon for my opinions are typically referenced expressly below. In addition to the relied-upon documents, I have also reviewed both parties' disclosures under Patent Local Rules 4-1 and 4-2. I also understand that Elantech Devices Corporation ("Elantech") may present its interpretation of some of the disputed claim terms at issue at the same time that this report is served. If necessary, I may present rebuttal opinions to such proposed interpretations at a later date. I reserve the right to modify or supplement the explanations and evidence presented in this report accordingly.

C. Compensation.

8. Regardless of the content of my opinions or the outcome of the case, I am being compensated at my ordinary rate of $350 an hour for my time devoted to participating as an expert in this case.

II. OPINIONS TO BE EXPRESSED.

9. The patent at issue in this case is directed to the use of touch-sensor devices to interpret and convey information relating to gestures performed on touch-sensor devices. In this report I will address the interpretation of certain terms used in the claims of the '978 Patent. The '978 Patent claims relate to a method and apparatus for examining capacitance profiles to determine an occurrence of a single gesture resulting from the simultaneous presence or proximity of at least two user input objects. ['978 Patent - 53:35-54:61.]

10. In the early-1990's, the people who were developing technology for use in touch sensor devices (*i.e.*, one of ordinary skill in the art) would have had at least a B.S.E.E. and three or so years of practical experience. Of course, the higher the educational training, the less practical experience one would need. For example, an engineer with a master's degree would need probably only a year or two of experience in the area to be able to tackle the design of such circuitry.

11. In explaining how one of ordinary skill in the art would interpret the words in the claims of the patents-in-suit, I understand that I am to focus on the teachings in the patent itself and on the correspondence recorded in the prosecution of the patents. I also understand that I am to explain how one of ordinary skill in the art would understand the claim terms in June 1992, roughly the time of the inventions claimed in the '978 Patent. In my analysis I will also present excerpts from dictionaries, both scientific and non-scientific, and statements in the relevant literature, including Elantech's U.S. Patent No. 5,825,352 ("the '352 Patent"), with respect to the terms and concepts that are claimed. Note that, in particular with respect to the '352 Patent, the basic concepts and terminology used in the art did not change substantially from the 1994 time frame of the inventions claimed in the '978 Patent and the later filed application to the '352 Patent. In using these types of extrinsic evidence, I will only refer to information that is consistent with the teachings and definitions used by the inventors in the patent at issue. I understand that I am not to

impose my own interpretation of the words or to present evidence of the meaning of terms that contradicts or varies the meanings as used in the patents. I understand that a key issue in determining the meaning of the claims is how certain terms were used and understood by skilled artisans in or about 1992.

A. '978 Patent Claim Terms To Be Construed.

12. I understand that the following claims in the '978 Patent are being asserted. The asserted claims are set out in full below:

> 1. A method of processing a user input received on a capacitive touch sensor pad including a matrix of X and Y conductors, the method comprising the steps of: developing capacitance profiles in one of an X direction and a Y direction from said matrix of X and Y conductors, said capacitance profiles identifying a simultaneous presence of at least two user input objects on said capacitive touch sensor pad; examining said capacitance profiles to determine an occurrence of a single gesture resulting from the simultaneous presence of the at least two user input objects; and indicating the occurrence of said single gesture resulting from said simultaneous presence of the at least two user input objects.
>
> 2. The method of claim 1 wherein said single gesture is indicated by a signal representing a simulated mouse button click.
>
> 3. The method of claim 1 wherein developing capacitance profiles comprises developing capacitance profiles in both said X and Y directions from said matrix of X and Y conductors.
>
> 4. A capacitive sensor comprising: a matrix of X and Y conductors; sensing circuitry coupled to each of said X and Y conductors and configured to generate outputs based on the capacitance of said X and Y conductors; and an arithmetic unit coupled to said sensing circuitry and configured to develop a first capacitance profile in an X direction in response to said outputs of said sensing circuitry, and to examine said first capacitance profile to determine an occurrence of a single gesture resulting from the simultaneous proximity of at least two input objects to said matrix of X and Y conductors.
>
> 6. The capacitive sensor of claim 4 wherein said arithmetic unit is configured to develop a second capacitance profile in a Y direction in response to said outputs of said sensing circuitry.
>
> 8. The method of claim 1 wherein the at least two input objects are fingers.

> 9. The capacitive sensor of claim 4 wherein the at least two input objects are fingers.
>
> 10. An input device comprising: a matrix of conductors; sensing circuitry coupled to each of said conductors and configured to generate outputs based on the capacitance of said conductors; and an arithmetic unit coupled to said sensing circuitry and configured to develop at least one capacitance profile in response to said outputs of said sensing circuitry, to examine said at least one capacitance profile to determine an occurrence of a single gesture resulting from the simultaneous proximity of at least two input objects to said matrix of conductors, and to indicate the occurrence of said single gesture resulting from said at least two input objects.
>
> 11. The input device of claim 10 wherein the single gesture is indicated by a signal representing a simulated mouse action.
>
> 13. The input device of claim 11 wherein the simulated mouse action comprises a button press.
>
> 16. The method of claim 1 wherein the single gesture is indicated by a signal representing a simulated mouse action.
>
> 18. The method of claim 16 wherein the simulated mouse action comprises a button press.

13. It is my understanding that the parties have requested that the following terms be construed:

gesture
capacitance profile(s)
developing capacitance profiles; develop a first capacitance profile; develop at least one capacitance profile; develop a second capacitance profile
identifying the simultaneous presence of at least two user input objects
examining said capacitance profiles to determine an occurrence of a single gesture; examine said first capacitance profile to determine an occurrence of a single gesture; examine at least one capacitance profile to determine an occurrence of a single

gesture
single gesture resulting from the simultaneous presence of the at least two user input objects; single gesture resulting from the simultaneous proximity of at least two user input objects; single gesture resulting from the simultaneous proximity of at least two input objects
indicating the occurrence of said single gesture; indicate the occurrence of said single gesture
signal representing a simulated mouse button click; simulated mouse button click signal representing a simulated mouse action; simulated mouse action
developing capacitance profiles in both X and Y directions
capacitive sensor
sensing circuitry
configured to generate outputs based on the capacitance
arithmetic unit
button press
simultaneous presence; simultaneous proximity

1. "gesture"

14. The term "gesture" is a commonly used term of art in input devices for graphical user interfaces and specifically in touch-based user interface devices. In the context of a touch-based user interface device (and thus in the context of the '978 Patent claims which all relate to such a device), "gesture" means "finger or object action that communicates an input to a device." The term "gesture" is consistently used with this meaning throughout the '978 Patent specification and claims.

15. The specification clearly teaches that the term "gesture" refers to any of a wide range of finger or object actions and is not restricted to a specific limited type of action. For

example, the specification states that "Touch sensor pointing devices can offer 'gestures,' which are special finger motions that simulate mouse button actions without the need for physical switches." ['978 Patent, 33:57-60.] This clearly includes a wide range of such finger motions. The specification further provides numerous examples of the types of finger actions it considers to be gestures. For example, "FIGS. 15A through 15G are timing diagrams illustrating some of the gestures that may be recognized according to the present invention." ['978 Patent, 8:38-40.] Figures 15A through 15G illustrate aspects of the Tap, Drag, Locking Drag, Drag Extension, Double Tap, and Hop gestures, each involving a different finger action. These gestures are discussed in detail in the specification. ['978 Patent, 5:21-36, 7:39-49, 27:35-40, 31:38-44, 33:42-53, 34:57-40:58, 42:44-48, 42:50-46:45.] The specification also discusses a "push" gesture ['978 Patent, FIG. 19, 4:50-52, 8:48-49, 34:7-8, 41:42-48, 50:3-53] and a "zig-zag" gesture ['978 Patent, 34:7-8, 40:35-39, 46:46-50:2.] The background discussion is also clear that the scope of the term "gesture" is broad and includes multiple-finger actions. Furthermore, the specification is clear that the action can come from a finger or any other sensed object, saying, "In the following discussion, the word 'finger' should be interpreted as including a stylus or other conductive object as previously described." ['978 Patent, 33:62-65.]

16. Additionally, the applicant explained the meaning of gesture to the examiner in remarks that lead to the allowance of the patent. "In particular, each of the claims recite that the user indicates a desired gesture (e.g. tapping, scrolling, dragging, etc.) by placing two objects (e.g. fingers) on or near the touch pad." [*See* '978 Patent Prosecution History, December 7, 2005 Amendment (Applicant Arguments/Remarks), at 6.] Once again, this indicates the breadth intended by the word "gesture". It is my understanding that Elantech has provided no alternative construction for this term.

2. "capacitance profile(s)"

17. The ordinary meaning of the term "capacitance profile" is clear to one of ordinary skill in the art with respect to the class of capacitive sensing devices described and claimed in the '978 Patent. These devices use sensors comprised of a plurality of capacitance sensing lines or

traces. It is advantageous to aggregate the individual capacitive information measured on these conductive lines into some type of data structure. A skilled artisan would refer to this collection of information as a capacitance profile. Thus, the term "capacitance profile" should be simply construed as "capacitive information on conductive lines." The specification does not limit this term to only apply to a complete set of information about every line on the sensor. It also does not limit the claimed capacitance profile based on the timing of how and when the information is obtained. Furthermore, Elantech's '352 Patent uses the analogous term "finger profile" to refer to the same type of capacitive information on conductive lines, even though the lines may be scanned sequentially or concurrently. [*See* '352 Patent, 5:44-55, 7:34-40]. Absent specific teachings in the '978 Patent specification or claims, a skilled artisan would have no reason to narrow this term beyond the plain meaning I have provided above.

18. The '978 Patent specification clearly supports such a construction, stating "the capacitive information from the sensing process provides a profile of the proximity of the finger to the sensor in each dimension." ['978 Patent, 7:3-5; *see also* 12:29-31]. The specification is also clear that this information can be analog or digital. ['978 Patent, 7:6-12]. More detail about one example of a capacitance profile is provided for a preferred embodiment. ['978 Patent, 9:44-58.]

3. "developing capacitance profiles" and similar terms

19. The claims further use the term "developing capacitance profiles" and the related terms "develop a first capacitance profile," "develop at least one capacitance profile," and "develop a second capacitance profile." It is my opinion that these terms can be construed together such that developing capacitance profiles and the additional words "first", "second", and "at least one" have their ordinary plain meaning. Given the understanding of "capacitance profile" explained above, the meaning of the term "developing capacitance profiles" is quite clear. It is the process that one of ordinary skill in the art would understand to be used for the creation of a capacitance profile. More specifically, this claim phrase would be understood to mean "sensing and quantifying capacitive information on conductive lines." One such process is clearly disclosed in the specification in the context of a preferred embodiment, "The capacitance of a plurality of

conductive lines running in a first direction (e.g., "X") is sensed by X input processing circuitry 12 and the capacitance of a plurality of conductive lines running in a second direction (e.g., "Y") is sensed by Y input processing circuitry 14. The sensed capacitance values are digitized in both X input processing circuitry 12 and Y input processing circuitry 14." ['978 Patent, 9:47-53.] One of ordinary skill would understand that the only steps required to develop a capacitance profile are to sense and to quantify the relevant capacitive information.

20. Elantech has suggested a much narrower construction that involved incorporating limitations from specific disclosed embodiments. In particular, Elantech suggest that developing a capacitance profile requires that the capacitance on *all* traces in a particular direction be measured *simultaneously*. Neither of these limitations is taught by the patent. The preferred embodiment disclosed in the specification does perform simultaneous measurement of traces in order to mitigate certain potential noise issues; however this is not a limitation on all embodiments. [*See* '978 Patent, 9:16-20.]

> There are two drive/sense methods employed in the touch sensing technology of the present invention. According to a first and presently preferred embodiment of the invention, the voltages on all of the X lines of the sensor matrix are simultaneously moved, while the voltages of the Y lines are held at a constant voltage, with the complete set of sampled points simultaneously giving a profile of the finger in the X dimension. Next, the voltages on all of the Y lines of the sensor matrix are simultaneously moved, while the voltages of the X lines are held at a constant voltage to obtain a complete set of sampled points simultaneously giving a profile of the finger in the other dimension.
>
> According to a second drive/sense method, the voltages on all of the X lines of the sensor matrix are simultaneously moved in a positive direction, while the voltages of the Y lines are moved in a negative direction. Next, the voltages on all of the X lines of the sensor matrix are simultaneously moved in a negative direction, while the voltages of the Y lines are moved in a positive direction. This technique doubles the effect of any transcapacitance between the two dimensions, or conversely, halves the effect of any parasitic capacitance to ground. In both methods, the capacitive information from the sensing process provides a profile of the proximity of the finger to the sensor in each dimension. ['978 Patent, 6:49-7:5.]

Note that the first and presently preferred embodiment specifically describes "the complete set of sampled points simultaneously giving a profile of the finger" while the second described method

only mentions moving the line voltages simultaneously. The second method makes no mention of sensing or measuring the lines simultaneously (as opposed to sequentially or in groups), nor does it state that all lines must be incorporated into the capacitive profile. Given the specific disclosure of an alternate embodiment that does not include these narrow limitations, one of ordinary skill would not understand them to be limitations on this simple claim term. Without an explicit, clear limitation in the specification, one of ordinary skill would understand "developing capacitance profiles" broadly include all methods of sensing and quantifying the capacitive information on the conductive lines, whether simultaneous or sequential and including any plurality of lines to be profiled.

4. "identifying the simultaneous presence of at least two user input objects"

21. Claim 1 uses the phrase "identifying the simultaneous presence of at least two user input objects." No special definition of this phrase is provided in the specification. Furthermore, it is comprised of ordinary words used in the ordinary way. To "identify" whether there is a "simultaneous presence of at least two user input objects" simply means to recognize the existence of such a presence, or to decide or determine that such a presence has occurred. Thus, the plain meaning of this phrase is the same to one of ordinary skill in the art is simply based on the plain meaning of the individual words in the context of the claim and the methods and devices taught by the patent, *i.e.*, "determining that two objects or fingers are on or near the touch pad." In the context of the patented devices and methods, the included phrase "the simultaneous presence of the at least two user input objects" clearly means that two objects or fingers are on or near the touch pad. The patent is clear that it uses finger, object, and stylus interchangeably to refer to the sensed object. ['978 Patent, 33:62-65.]

22. Elantech has asserted that this claim term is limited to "recognizing a second finger tap." The plain language of the claim is clearly broader. In the first place, the user input object need not be a finger. ['978 Patent, 33:62-65.] Secondly, two objects can be present simultaneously without the second finger being tapped. The second finger can be stationary on the touch sensor or moving on the touch sensor; both constitute a simultaneous presence of at least two

input objects. In fact, the specification uses this language ("presence") to reflect the placement of a second finger prior to the determination of whether a tap has occurred. "When a second finger comes down on the pad, the (X, Y, Z) values typically take two or three samples to converge to their new values which reflect the presence of two fingers." ['978 Patent, 48:37-39.] It also discusses one way to measure the presence of two fingers on the pad at the same time, "(When two fingers are on the pad, the apparent position reported is midway between the two fingers.)" ['978 Patent, 46:52-53], and further explains that adequate information is available to discern more than one type of multi-finger gesture. "However, unlike prior art, because the entire pad is being profiled, enough information is available to discern simple multi-finger gestures to allow for a more powerful user interface." ['978 Patent, 7:17-20.] The specification also discloses that the sensor can detect multiple touching points in a joystick mode, where long touches rather than taps would be the norm, and in a musical keyboard where multiple notes or chords would commonly be held. ['978 Patent, 53:1-16.] Even the abstract describes the "an application of at least two objects on the capacitive touch sensor pad" and not merely a tap. Furthermore, Elantech's construction would encompass the "hop" gesture which often uses a tap of a second finger even though the patent teaches that this gesture "never involves more than one finger on the pad at any one time." ['978 Patent, 40:36-37.] The detection of a second finger tap is a characteristic of one described embodiment of a zigzag gesture, and the patent provides no indication that this is a limitation on the more general phrase "identifying the simultaneous presence of at least two user input objects."

23. The same language, "simultaneous presence," is used in every claim of Elantech's own '352 Patent, which is in the same field of art. The term is not specifically described in the '352 Patent specification, which indicates that the '352 Patent authors intended for it to have an ordinary meaning. In fact, the specific term "simultaneous presence" does not appear outside of the claims in the '352 Patent. However, the '352 Patent specification discloses numerous gestures including the "presence of two fingers engaged in relative motion" representing a drag gesture ['352 Patent, 13:19-20], a tap by a second finger when the first finger is already on the sensor ['352 Patent, 13:4-12], a tap by two fingers at the same time ['352 Patent, 13:23-31], a tap by three fingers at the same time ['352 Patent, 13:32-44], and a gesture where the first finger is held

stationary on the sensor while the second is moved in a stroke along the sensor ['352 Patent, 13:44-58]. It appears that the language "simultaneous presence of two fingers" in the '352 Patent claims is intended to encompass all of these gestures and not just a "second-finger tap" as Elantech now seeks to limit the '978 Patent.

5. "examining said capacitance profiles to determine an occurrence of a single gesture" and similar terms.

24. As I have previously explained, a capacitance profile is information (data) about the capacitance on conductive lines. Furthermore, a gesture is a finger or object action that communicates an input to a device. As such, the plain meaning of this phrase is clear. The information in the capacitance profile must be examined for the purpose of determining if a gesture has occurred. To make such a determination requires processing the information in the profile; therefore, this phrase should be construed to mean "processing the capacitance profile information to determine that a gesture has occurred." In general, this is the plain meaning of the words in the claim; however, one of ordinary skill in the art reading this phrase would understand that "examining … to determine" requires more than simply reading the information, it requires further processing the information to make a determination. The specification describes the object of the invention is similarly general terms. "According to a further object of the present invention, a number of gestures made by a finger or other object on the touch-sensor pad are recognized and communicated to a host." ['978 Patent, 7:43-46.] The file history also indicates that these words are intended to relate to a variety of gestures. "In particular, each of the claims recite that the user indicates a desired gesture (e.g. tapping, scrolling, dragging, etc.) by placing two objects (e.g. fingers) on or near the touch pad. The single gesture is recognized through examination of capacitance profiles developed across a matrix of conductors included within the sensor pad to identify the simultaneous presence of two fingers or other objects." [*See* '978 Patent Prosecution History, December 7, 2005 Amendment (Applicant Arguments/Remarks), at 6.]

25. Elantech has suggested that this phrase has a very narrow meaning that corresponds to one disclosed embodiment. They read in specific steps from an embodiment in the specification including "computing the centroid (*i.e.* X,Y position) and pressure information (*i.e.* Z value)

information" and "comparing (X,Y,Z) values to recognize a second-finger tap." It is clear to one of ordinary skill and perhaps to any reader that there are many ways to examine the capacitance profile and that not every such examination requires computing a centroid. Furthermore, the claim phrase involves determining "the occurrence of a single gesture." Many different types of gestures are disclosed in the patent (*see* ¶15) and other similar gestures would be obvious to one of ordinary skill in light of this patent. There is no teaching in the patent that would limit the use of the word gesture in this claim phrase to only a "second-finger tap."

6. "single gesture resulting from the simultaneous presence of the at least two user input objects" and similar terms.

26. The phrase "single gesture resulting from the simultaneous presence of the at least two user input objects" and the related phrases "single gesture resulting from the simultaneous proximity of at least two user input objects" and "single gesture resulting from the simultaneous proximity of at least two input objects" have simple, plain meaning given the meaning of the contained words and phrases explained above. The phrase "the simultaneous presence of the at least two user input objects" means that at least two objects or fingers are on or near the touch pad.[1] A gesture is a finger of object action that communicates an input to a device. A single gesture is simply one gesture. Therefore, a "single gesture resulting from the simultaneous presence of the at least two user input objects" is simply one gesture resulting from the simultaneous presence of at least two user input objects, *i.e.*, one gesture resulting from at least two objects or fingers on or near the touch pad. The related phrases have the same meaning in the context of this patent.

27. Elantech has suggested that this phrase, which clearly describes a general class of gestures in plain language, be restricted to a single example from an embodiment in the patent. The patent describes many types of gestures [*see* ¶15] and discusses the ability to detect the

[1] Synaptics requested construction of these terms in its initial Patent Local Rule 4-1 Disclosure, but these phrases will be construed as part of the longer phrases that Elantech has proposed for construction. The terms "simultaneous presence" and "simultaneous proximity" simply mean that "two objects or fingers are on or near the touch pad." *See* ¶21-22 and ¶26-27.

presence of two fingers in a broader set of instances than merely a second-finger tap [*see* ¶22]. There is nothing in the specification that would lead one of ordinary skill to disregard the plain meaning of this claim phrase and instead substitute a single example from an embodiment. To the contrary, the patent provides adequate teachings to one of ordinary skill in the art to enable the understanding of a variety of two-or-more-finger gestures. In fact, the claim language itself contemplates more than two fingers, saying, "*at least* two [user] input objects." ['978 Patent, 53:48-49; 54:4-5; 54:36-37 (emphasis added).] The file history also refers to this claim element as "multiple simultaneous user inputs present on a touch pad sensor." [*See* '978 Patent Prosecution History, December 7, 2005 Amendment (Applicant Arguments/Remarks), at 7.] It would make no sense to read the "*at least* two user input objects" language to be limited to only the second finger nor to read the words "simultaneous presence" to be limited to a tap.

7. "indicating/indicate the occurrence of said single gesture"

28. The phrase "indicate the occurrence" has a somewhat specific meaning in the art of computer input devices that is related to (but does not exactly match) the dictionary meaning of the words that one would find in a traditional dictionary. For this reason, some clarification of this term in the context of this patent would likely be useful to a jury. To indicate the occurrence, in this context, means to transfer information that specifies that an event has happened. This transfer can be to another device or simply to another software entity on the same device. Therefore, given the meaning of gesture [*see* ¶14], the complete phrase "indicating/indicate the occurrence of said single gesture" means "transmitting information to another module, routine, function, or device that indicates that a gesture has occurred based on the simultaneous presence of at least two input objects." One of ordinary skill in the art would not read this claim language to limit the claimed gesture to only a "second-finger tap." [*See* ¶26-27.]

8. "signal representing a simulated mouse button click"; "simulated mouse button click"; "signal representing a simulated mouse action"; "simulated mouse action"

29. Signal is a broad term in the art that refers to any of a variety of ways of conveying information from one circuit or device to another. In fact, Judge Breyer has ruled that "[t]he word

'signal' is used broadly throughout the '931 patent," another Synaptics patent with a nearly identical specification. [*See* April 6, 2007 Claim Construction Order, *Elantech Devices Corp. v. Synaptics, Inc. et al*, Case No. 3:06-cv-01839-CRB [Docket No. 91], at 8.] There is nothing in the '978 Patent specification that indicates that the meaning of "signal" is not also broad in these claims. In my opinion, the meaning and scope of the word "signal," an important word in the art, can be effectively explained to the Jury without further construction.

30. The other phrases within these phrases that require some construction are "simulated mouse button click" and "simulated mouse action." A computer incorporates a number of hardware and software interfaces that process input data from a user input device. In particular, many computers have hardware and software interfaces that were originally designed to receive communications from a mouse indicative of various actions or events. At any of these interfaces, a similar or identical signal can be presented from an alternative input device, like a touch sensor, that represents the same action or event. Such a signal would be described in the art as a simulated mouse event or a simulated mouse action, as it has a similar or identical effect but does not actually come from a real mouse device. Given this meaning within the art, a "signal representing a simulated mouse button click" and a "simulated mouse button click" both refer to any signal that represents to the system a mouse button click. Similarly, a "signal representing a simulated mouse action" and a "simulated mouse action" both refer to any signal that represents to the system a mouse action.

31. Elantech's suggested construction, "a value of LEFT or RIGHT denoting a second-finger tap," is both unreasonably limiting and of little use in providing clarity to a Jury. As an expert, I cannot currently determine what Elantech specifically intends when it refers to "a value of LEFT or RIGHT." There are instances of detailed implementations of embodiments disclosed in the patents where certain variables (such as TapButton and Out) can be set to values named LEFT, MIDDLE, RIGHT, or NONE [*see* '978 Patent, 35:57-62 45:5-9] as one of many steps in simulating a mouse button click, but there is no teaching in the specification that limits the meaning of "simulated mouse button click" to this specific action within the algorithm disclosed for one embodiment. Moreover, the language proposed by Elantech is ambiguous in regard to

even this specific step. There is nothing in the specification that would indicate to one of ordinary skill that the claimed signal should be limited to this one example and to the specific names of the values disclosed.

32. Additionally, the term "simulated mouse action" is clearly a different and broader term than "simulated mouse button click." A mouse can do more than just click and the term "mouse action" can embody other actions than clicking.

33. Finally, there is nothing in the specification to indicate that the claimed signal must represent a second-finger tap. To the contrary, the specification discloses many simulated mouse actions and simulated mouse button clicks that are unrelated to a second finger tap. [*See, e.g.*, '978 Patent, Figs. 15A-15G, 33:50-65, 34:19-56.] Also the patent states, "[r]eferring back to FIG. 1, according to another aspect of the present invention, gesture unit 20 examines the (X,Y,Z) data produced by arithmetic unit 16 to produce one or more "virtual mouse button" signals to be sent along with the (ΔX, ΔY) signals to the host." ['978 Patent, 33:66-34:3.] Gesture unit 20 processes single-finger taps, corner taps, double taps, scroll motions, drags, and pushes, all of which do not require a "second-finger tap" yet produce simulated mouse actions. ['978 Patent, 34:4-8.] This is supported by numerous passages in the specification including the following:

> FIGS. 17A through 17F comprise a flowchart for the operation of tap unit **280**. Tap unit **280** implements the tap, drag, locking drag, drag extension, corner-tap, and hop gestures described herein. In the gesture recognition operations described herein, the cornertap is used to simulate the right virtual mouse button. Hops to the left and right are used to simulate the middle and right virtual mouse buttons. Simple taps simulate the left (primary) virtual mouse button. ['978 41:28-36.]
>
> Tap unit **280**, zigzag unit **282**, and push unit **284** examine the sequence of (X,Y,Z) samples to look for various types of gestures. The outputs of all these units, plus the switch signals, are combined in button control unit **286** to produce the actual button-press signals sent to the host. In the illustrative example disclosed herein, the touchpad simulates a three-button (Left, Middle, Right) pointing device. The system of FIG. 14 could clearly be extended to support other gestures than those described here, or to support fewer gestures in the interest of simplicity.
>
> Button control unit **286** can use any of several well-known methods for combining multiple signals. For example, a priority ordering can be established among the various sources, or each button output (Left, Middle, and Right) can be asserted ("clicked", "pressed" or

> "held down") whenever any of the sources indicate that button. Any particular method of combining these signals is a routine design detail dependent on a particular system configuration, which may be easily implemented by persons of ordinary skill in the art.
>
> In a presently preferred embodiment, the button control unit **286** maps both switches and gestures to the most commonly used virtual buttons, giving maximum flexibility to the user. In an alternate embodiment, switches and gestures can be mapped to different virtual buttons so that a larger number of virtual buttons can be covered without resort to exotic gestures. Or, the user can be offered a choice of mappings.
>
> It is well known in the art to allow extra button switches to be processed as specialized commands, such as double-clicking, selecting commonly used menu items, etc., instead of their normal role as mouse buttons. Similarly, the button control unit **286** or host software could map some of the gestures described here to software commands instead of simulating mouse buttons. Such processing and mapping is well within the realm of ordinary skill in the art. ['978 Patent, 34:19-56.]

9. "developing capacitance profiles in both said X and Y directions"

34. "Developing capacitance profiles" means "sensing and quantifying capacitive information on conductive lines." [*See* ¶19.] The terms "X" and "Y" in these claims are simply arbitrary names for two different directions. Thus "developing capacitance profiles in both X and Y directions" simply means "sensing and quantifying capacitive information on conductive lines running in a first direction and in a second direction." The added limitations that Elantech has suggested that all sensor traces must be individually and simultaneously measured are in some cases characteristics of disclosed embodiments, but are in no way suggested by the claim language at issue or limited by specific teachings in the specification. [*See* ¶19-20.]

10. "capacitive sensor"

35. A sensor is simply a device that senses some phenomena. In the context of this patent, a capacitive sensor is "a device with a plurality of conductive lines that senses capacitive information." Such a sensor is disclosed in the patent specification. ['978 Patent, 7:53-67, 9:26-29, 9:44-58.] Furthermore, it is made clear that such a sensor can be constructed from a variety of materials in a variety of ways. ['978 Patent, 10:7-25.]

11. "sensing circuitry"

36. Circuitry is a commonly used term in the art. A circuit is an "interconnection of electrical elements." [*See* SYNAP 0001444-45, The IEEE Standard Dictionary of Electrical Terms (Sixth Edition) at 156.] Sensing refers to the process of detecting or measuring some phenomena. Thus a sensing circuit is a circuit used for sensing, *i.e.*, an "interconnection of electrical elements that is used in the sensing of some phenomena."

12. "configured to generate outputs based on the capacitance"

37. The term "outputs" is used to describe information that is transferred from a process or device. [*See* SYNAP 0001450, The Modern Dictionary of Electronics (1999) at 528.] Generating outputs means producing information to be transferred from a process or device. Thus "configured to generate outputs based on the capacitance" means "set to produce information based on the measured capacitance." [*See also* '978 Patent, 13:29-40.]

13. "arithmetic unit"

38. The term "arithmetic unit" is used broadly in this specification to refer to any component that can perform arithmetic. The specification explains that the arithmetic unit "uses the digital information to derive digital information representing the position and pressure of the finger 8 or other conductive object" ['978 Patent, 9:55-58], and also that the arithmetic unit "may be configured as hardware elements or as software running on a microprocessor as will be readily understood by those of ordinary skill in the art." ['978 Patent, 21:2-5, *see also* 21:41-53.] Given this broad disclosure, an "arithmetic unit" is "a functional component of a computer system that performs arithmetic operations."

14. "button press"

39. This term has its plain ordinary meaning. Button press refers to an act of pressing a button.

III. CONCLUSION.

40. I understand that I may be called upon to respond to any issues raised by the Elantech's expert or experts or the Court. I anticipate that I might supplement or modify the opinions in this report in view of any such new information or other new information that might arise between now and the time of the briefing and hearing on the claim construction issues.

Dated: July 14, 2008

Andrew Wolfe, Ph.D

CERTIFICATE OF SERVICE

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EXPERT REPORT OF ANDREW WOLFE Ph.D. CONCERNING CLAIM CONSTRUCTION FOR U.S. PATENT NO. 7,109,978

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Akin Gump Strauss Hauer & Feld LLP	______ Overnight
2 Palo Alto Square, Suite 400	__X__ Personal
3000 El Camino Real	______ E-mail (courtesy copy)
Palo Alto, Ca 94306	
Tele: (650) 838-2121	
Fax: (650) 838-2001	
Email: yhu@akingump.com	
sdebruine@akingump.com	
rchae@akingump.com	
Counsel for Defendant	
Elantech Devices Corp.	

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed at Palo Alto, California on July 14, 2008.

Andrea M. Vickery ______________________ *Andrea M. Vickery*
(typed)

KARL J. KRAMER (CA SBN 136433)
ERIKA L. YAWGER (CA SBN 234919)
LAURA R. MASON (CA 252251)
MORRISON & FOERSTER LLP
755 Page Mill Road
Palo Alto, California 94304-1018
Telephone: (650) 813-5600
Facsimile: (650) 494-0792
KKramer@mofo.com

Attorneys for Plaintiff
SYNAPTICS INCORPORATED

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

SYNAPTICS INCORPORATED, a Delaware corporation, Plaintiff, v. ELANTECH DEVICES CORP., a corporation existing under the laws of Taiwan, R.O.C., Defendant.	Case No. CV 07 6434 CRB **REBUTTAL EXPERT REPORT OF ANDREW WOLFE PH.D. CONCERNING CLAIM CONSTRUCTION FOR U.S. PATENT NO. 7,109,978**

I. BACKGROUND AND QUALIFICATIONS

1. I have been asked to respond to the July 14, 2008 expert report of Dr. Ian Scott MacKenzie in order to further establish those areas in which I disagree with his opinion and to highlight areas in which his report is simply incorrect. My opinions as to the appropriate meaning to one of ordinary skill in the art of the claim terms at issue in this case are contained in my July 14, 2008 expert report and incorporated herein by reference. After reviewing Dr. MacKenzie's report, none of those opinions have changed. In this report I will clarify why statements in Dr. MacKenzie's report are either incorrect or not relevant to the meaning of the disputed claim terms to one of ordinary skill in the art. My July 14, 2008 report also contains my background, qualifications, and required disclosures related to this case.

II. OPINIONS TO BE EXPRESSED

2. Dr. MacKenzie has provided his understanding of the level of education and experience that would typify one of ordinary skill in the art with regard to this patent. [Expert Report of Dr. Ian Scott MacKenzie Regarding Claim Construction of U.S. Patent No. 7,109,978 ("MacKenzie") ¶5.] My opinion on ordinary skill was also provided in my prior report. [Expert Report of Andrew Wolfe Ph.D. Concerning Claim Construction for U.S. Patent No. 7,109,978 ("Wolfe") ¶10.] Our definitions of one of ordinary skill in the art differ slightly, with Dr. MacKenzie's definition including one additional year of experience, but I do not believe that the difference is significant nor that it should substantially impact the meaning of any of the claim terms. Notably, however, under Dr. MacKenzie's definition, one of ordinary skill in the art would have a more established understanding of the usage of common terms in the art and would therefore rely less on the embodiments disclosed in the patent to understand the meaning of terms.

3. The majority of the terms for which a construction has been requested are ordinary words that have the same meaning within this patent and within the art as they do in everyday conversation. For example, the term "identifying the simultaneous presence of at least two user objects" incorporates no special jargon or other words that have unique meaning in this field. It simply means what the words say. One of ordinary skill would rely on his understanding of these ordinary English words in reading the claims of this patent. The teachings and exemplary embodiments disclosed in the patent specification are consistent with the ordinary meaning of these words and there are no specific teachings in the patent to indicate that the plain English meaning does not apply.

4. A few terms, such as "gesture" and "capacitance profile" have specific meaning within the field of touch-panel input devices that would be well known to one of ordinary skill in the art. Touch-panel input devices predate this patent by at least 15 years. Many patents have been filed and many devices have been produced. This patent alone lists over 200 pieces of prior art. As such, a skilled practitioner would be familiar with numerous terms of art that had established meaning within the field. This patent uses terms like "gesture" and "capacitance

profile" consistently with industry-wide usage at the time of the patent filing. There are no specific teachings in the patent to indicate that the ordinary meaning within the field of art does not apply to any of the requested terms. One of ordinary skill in the art would thus apply this ordinary meaning when understanding the claims.

5. Each of the terms that either party has requested to be construed would be understood by one of ordinary skill in the art to have its ordinary meaning, either the plain meaning of the words in common English or the established meaning of terms of art. While one of ordinary skill would interpret these terms in light of the specification and claim language, there is nothing in U.S. Patent No. 7,109,978 ("'978 Patent") specification or claims that indicates that any of the requested terms should have any unique or special meaning when used in this patent. The patent does disclose specific examples of embodiments of the claims; however, it never specifies that any of the requested claim terms should be read to be limited to these disclosed embodiments.

6. In general, Dr. MacKenzie appears to disregard the plain English meanings of the requested terms as well as any established meanings within the art. Instead, he has opined that each of these common phrases has a very narrow meaning describing one of the embodiments disclosed in the '978 Patent. In some cases, Dr. MacKenzie's narrow understanding of claim terms and phrases simply cannot be true since other embodiments are also disclosed in the '978 Patent. In every case, however, Dr. MacKenzie's overly narrow definition is an unreasonable interpretation of the claim language. As Dr. MacKenzie has agreed, one of ordinary skill in the art would have a degree in a relevant field and several years of experience with human-computer interface issues. Certainly, such a person would understand the ordinary meanings of common terms of art, and would understand that the embodiments provided in the patent are merely exemplary and not definitional. Moreover, one with such a substantial level of experience would understand from the examples provided in the '978 Patent that a range of embodiments is disclosed, and that the claims would not be limited to embodiments that are fully detailed.

7. Some of Dr. MacKenzie's assertions are simply incorrect. For example, Dr. MacKenzie states that "[a] zigzag processor is described for recognizing this second-finger tap.

No other two-finger gestures are described in the '978 patent." [MacKenzie ¶7.] In fact, other two-finger gestures are described in the '978 Patent specification and further explained in argument to the examiner within the prosecution history. For example, the specification discloses that the sensor can detect multiple touching points in a joystick mode, where long touches rather than taps would be the norm, and in a musical keyboard where multiple notes or chords would commonly be held. ['978 Patent, 53:1-16.] The specification also describes the "Hop" gesture as a gesture that involves two fingers. ['978 Patent, 40:35-39.] The specification also more generally explains that "The system of FIG. 14 could clearly be extended to support other gestures than those described here, or to support fewer gestures in the interest of simplicity."['978 Patent, 34:27-30.] Additionally, the applicant explained to the examiner that the claims recite a variety of two-finger gestures in remarks that led to the allowance of the patent. "In particular, each of the claims recite that the user indicates a desired gesture (e.g. tapping, scrolling, dragging, etc.) by placing two objects (e.g. fingers) on or near the touch pad." [See '978 Patent Prosecution History, December 7, 2005 Amendment (Applicant Arguments/Remarks) at 6.]

8. Dr. MacKenzie also asserts that "[t]he asserted claims 1-4, 6, 8-11, and 13, 16, and 18 of the '978 patent are directed to detecting a second-finger tap." [MacKenzie ¶8.] In fact, none of the asserted claims mentions a second-finger tap. He then continues to describe the invention as limited to aspects of one preferred embodiment, many of which do not even apply to all disclosed embodiments. [MacKenzie ¶8.] For example, Dr. MacKenzie claims that the invention requires simultaneous measurement of the capacitances of sensor traces on the touchpad. [MacKenzie ¶8.] However, the passage he cites to support this proposition actually discloses embodiments that do not contain the limitations that Dr. MacKenzie imported into his proposed constructions. ['978 Patent, 6:49-7:20.] This cited passage discloses both a simultaneous measurement technique and one that permits any order of measurement. [*See* Wolfe Expert Report, ¶¶19-20.]

9. Dr. MacKenzie also describes the invention as limited to requiring the calculation of a centroid, an unclaimed feature which is clearly presented in the '978 Patent specification only as a characteristic of certain embodiments. [MacKenzie ¶8; '978 Patent, 7:6-17.] The '978

Patent clearly discloses that more detailed profile information is also available and could be used "to discern simple multi-finger gestures to allow for a more powerful user interface." ['978 Patent, 7:18-20.] This is a broad disclosure that teaches beyond the use of a centroid calculation for detecting multi-finger gestures.

10. Dr. MacKenzie also proposes a limited definition of the term "capacitance profile" based on a misreading of a word used in the '978 Patent specification. Dr. MacKenzie admits that "capacitance profile" is not used or defined in the specification, and indeed it need not be, since the term was used in the art and well understood by one of ordinary skill in the art at the time. [MacKenzie, fn. 1.] The patent refers to "the complete set of sampled points simultaneously giving a profile of the finger" ['978 Patent, 6:54-55.] Dr. MacKenzie misinterprets this statement as requiring that all sensor traces must be measured and incorporated into a capacitance profile. Although the patent refers to "the complete set of sampled points," it never states that the set of sampled points must include every trace on the sensor pad. The plain language in the patent simply requires that the "complete set" includes the measurements of the traces that are sampled. In the disclosed embodiments, the profile only contains information about a subset of traces that are oriented in the same direction. It is never the case that all sensor traces are measured to form a capacitance profile for any of the disclosed embodiments in the '978 Patent. Moreover, the "complete set" language is only used for one of two examples of embodiments of the invention. ['978 Patent, 6:43-7:5.] One of ordinary skill in the art would understand that a capacitance profile simply refers to capacitive information on conductive lines. "Capacitance profile" is the term in the art used to describe information about the capacitance measurements of sensor traces, whether that includes all sensor traces or a smaller set of sensor traces.

11. Dr. MacKenzie extends the improper "all traces" limitation into his definition of the claim term "developing capacitive profiles." He also improperly incorporates an additional characteristic of one disclosed embodiment, namely, that the traces are measured simultaneously. [MacKenzie ¶12.] Simultaneous sensing or measurement of the traces is disclosed for one embodiment, but it is never claimed. While such simultaneous sensing is described for one embodiment in the '978 Patent, it is conspicuously not described for a second embodiment. [*See*

Wolfe ¶¶19-20.] Both embodiments disclose driving or moving the X and Y conductors simultaneously, which is different from sensing traces simultaneously. This "simultaneous driving" feature is also specifically claimed in dependent claim 5 and not in the broader independent claim 4 which uses the language "develop a first capacitance profile."

12. Furthermore, in one embodiment, the sensing of traces in parallel is disclosed as the solution to a common-mode noise problem that is completely unrelated to the claims. ['978 Patent, 6:43-48; 15:57-60.] Simultaneous sensing has nothing to do with the '978 Patent multi-finger gesture claims. As such, one of ordinary skill in the art would never look to this portion of the disclosure in order to understand the meaning of a common term in the art like "developing capacitance profiles." This portion of the disclosure simply describes one way in which such a profile could be developed. One of ordinary skill, who is presumably familiar with the prior art, would clearly understand how to build the claimed invention from this disclosure while measuring traces simultaneously, sequentially, or in groups.

13. Dr. MacKenzie also has provided an unreasonably narrow interpretation of the claim term "identifying a simultaneous presence of at least two user objects." This term uses ordinary English words in the ordinary way. A reasonable, skilled artisan would not limit his understanding of these simple words to one example disclosed in the specification. "Simultaneous presence" simply means to be present at the same time. "At least two user objects" simply means two or more user objects. Dr. MacKenzie's claim that "one of ordinary skill in the art would understand this phrase to mean 'recognizing a second-finger tap'" is simply not a reasonable interpretation of these basic words. [MacKenzie ¶13.] Specifically, it is not rational to read the phrase "at least two user objects" as meaning "exactly two fingers" in the context of these claims. In fact, dependent claims 8 and 9 add the limitation that the objects must be fingers, thus a skilled artisan would not read this as a limitation of independent claims 1 and 4. The specification does disclose a zig-zag gesture that involves a second-finger tap, but there is no suggestion in the '978 Patent that the claims should be limited solely to this example gesture.

14. Dr. MacKenzie justifies his overly narrow construction by asserting that "the second-finger tap is the only two-finger gesture that can be recognized by the disclosed

invention." [MacKenzie ¶15.] Dr. MacKenzie's conclusion is both wrong and misdirected. The claims are not limited to two-finger gestures. They specifically call for at least two user objects, and thus encompass more than two fingers. Furthermore, the disclosed and claimed invention can recognize other gestures in addition to a second-finger tap.

15. Dr. MacKenzie appears to rely on statements about the "position sensor" in certain embodiments. [MacKenzie ¶15.] The full citation is as follows:

> The position sensor of these embodiments can only report the position of one object on its sensor surface. If more than one object is present, the position sensor of this embodiment computes the centroid position of the combined set of objects. However, unlike prior art, because the entire pad is being profiled, enough information is available to discern simple multi-finger gestures to allow for a more powerful user interface ['978 Patent, 7:13-20.]

The statements about reporting the position of one object and the calculation of the centroid are clearly limited to certain embodiments. The next sentence clearly teaches that "the entire pad is being profiled" and that "enough information is available to discern simple multi-finger gestures." As discussed above, a profile of the entire pad contains more than just a centroid measurement. Even by Dr. MacKenzie's definition, a capacitance profile would be "a complete set of capacitance measurements" and not merely a centroid. The cited statements also clearly teach more than just one type of two-finger gesture; they teach a plurality of "multi-finger gestures." Furthermore, the description of the embodiments only states that the position sensor can only report the position of one object. The position sensor is not the entirety of the invention. The additional statements clearly indicate that the invention as a whole is capable of providing additional information. Additionally, even the position sensors in these particular disclosed embodiments are not limited to a zig-zag gesture or a second finger tap. A centroid calculation can be used to detect numerous gestures including, for example, a two-finger stroke.

16. Other portions of the specification and file history also disclose that a finger profile, and not just a centroid, is available to detect a variety of multiple-finger gestures, including the joystick and musical instrument applications. [See ¶7 above.] The file history also clearly describes a variety of two-finger gestures. [See ¶7 above.] Furthermore, this same

phrase, "simultaneous presence," was used to describe a variety of multi-finger gestures in Elantech's later '352 Patent, which is from the same era and field of art.

17. Dr. MacKenzie's understanding of the claim terms "examine said first capacitance profile," "examine said at least one capacitance profile," and "examining said capacitance profiles to determine an occurrence of a single gesture" are also unreasonably narrow and unrelated to what one of ordinary skill would have understood at the time. Even Dr. MacKenzie's stated understanding of "capacitive profile" does not include limitations related to "a second-finger tap", "comparing (X, Y, Z) values," or "computing the centroid and pressure information," and yet he has imported all of those limitations into these claim terms. If none of these limitations are inherent in a capacitive profile, then they cannot reasonably be limitations on examining a capacitance profile. Everyone, including those of ordinary skill in the art, knows what the word examining means. There are many ways to examine something. One would understand the plain meaning of this word without importing every detail of an exemplary method from the specification. No reasonable reader of this claim would assume that the only claimed way to examine a capacitive profile is to compute the centroid and pressure information and compare (X, Y, Z) values in order to recognize one particular gesture. As explained in paragraph 7 above, the patent and the file history disclose many gestures and indicate that the information in the capacitive profile can be examined and evaluated in a variety of ways.

18. It is also clear that even the disclosed embodiment cited by Dr. MacKenzie is not necessarily limited to using only the (X, Y, Z) values to examine the capacitive profile. Additional specific examples, such as the width or shape of the sensor trace profile, are described as useful for recognizing multi-finger gestures.

> It is possible to recognize second-finger taps using only the (X,Y,Z) information from the standard arithmetic unit 16, as described herein. However, it is clear that the arithmetic unit 16 could be modified to produce additional information, such as the width or shape of the sensor trace profile, which would aid in the accurate recognition of this gesture. ['978 Patent, 47:3-9.]

Recognition of a gesture could also involve examining this information from the capacitive profile.

19. Dr. MacKenzie also unreasonably imports one example from the specification into his proposed construction of "single gesture resulting from the simultaneous presence of the at least two user input objects." Once again, these words are not unique to the patent and can be understood without any specific definition from the patent. The patent teaches several examples of multi-finger gestures, and a skilled artisan would understand the scope of this claim term without needing to be taught an example of every possible gesture. The claim language is quite clear. A single gesture is simply one gesture. The simultaneous presence of the at least two user input objects is simply two or more objects, such as fingers, that are present at the same time. One of ordinary skill would understand that there are many gestures that can be indicated or detected based on the presence of two or more objects at the same time.

20. Similarly, the phrase "indicating the occurrence of said single gesture" can refer to any single gesture. The patent teaches more than just a second-finger tap, and the plain language of the claim refers to any single gesture resulting from the simultaneous presence of the at least two user input objects. Indicating information to a host is done in a variety of ways in the patent, including with the use of packets of data similar or identical to those previously known in the art. [*See, e.g.*, '978 Patent, 22:37-41, 28:3-29, 33:54-65, 34:65-35:8, 35:26-41, 43:15-62, 46:57-47:2, 49:45-55, 51:63-52:5.]

21. Finally, it would be clear to one of ordinary skill in the art that a "signal representing a simulated mouse button click" can be any signal that represents a simulated mouse button click, and that a "signal representing a simulated mouse action" can be any signal that represents a simulated mouse action. There would be no reason for a skilled practitioner to limit these words to the values used in one example in the patent. The patent discloses numerous gestures that generate simulated mouse button clicks, including a middle button click that is not within the scope of Dr. MacKenzie's proposed construction. [*See, e.g.*, '978 Patent, FIG 17C, 34:27, 35:47-62]. The patent also discloses simulated mouse actions, such as cursor motion, that are unrelated to the values LEFT or RIGHT or to a second button click. [*See, e.g.*, '978 Patent, 35:26-41, 51:63-52:5.]

III. CONCLUSION

22. I understand that I may be called upon to respond to any issues raised by the Elantech's expert or experts or the Court. I anticipate that I might supplement or modify the opinions in this report in view of any such new information or other new information that might arise between now and the time of the briefing and hearing on the claim construction issues.

Dated: July 29, 2008

Andrew Wolfe, Ph.D.

CERTIFICATE OF SERVICE

I declare that I am employed with the law firm of Morrison & Foerster LLP, whose address is 755 Page Mill Road, Palo Alto, California 94304-1018. I am not a party to the within cause, and I am over the age of eighteen years.

I further declare that on the date hereof, I served a copy of:

REBUTTAL EXPERT REPORT OF ANDREW WOLFE PH.D. CONCERNING CLAIM CONSTRUCTION FOR U.S. PATENT NO. 7,109,978

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Yitai Hu Sean P. DeBruine Akin Gump Strauss Hauer & Feld LLP 2 Palo Alto Square, Suite 400 3000 El Camino Real Palo Alto, Ca 94306 Tele: (650) 838-2121 Fax: (650) 838-2001 Email: yhu@akingump.com sdebruine@akingump.com rchae@akingump.com Counsel for Defendant Elantech Devices Corp.	____ Fax ____ U.S. Mail ____ Overnight _X_ Personal _X_ E-mail (courtesy copy)

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed at Palo Alto, California on July 30, 2008.

Andrea M. Vickery	Andrea M. Vickery
(typed)	(signature)

EXHIBIT E

Yitai Hu (SBN 248085) (yhu@akingump.com)
Sean P. DeBruine (SBN 168071) (sdebruine@akingump.com)
S.H. Michael Kim (SBN 203491) (mkim@akingump.com)
Richard Chae (SBN 224610) (rchae@akingump.com)
AKIN GUMP STRAUSS HAUER & FELD LLP
3000 El Camino Real, Suite 400
Palo Alto, California 94306
Telephone: 650-838-2000
Facsimile: 650-838-2001

Attorneys for Plaintiff and Counter Defendant
ELANTECH DEVICES CORPORATION

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

SYNAPTICS, INCORPORATED, Plaintiff, vs. ELANTECH DEVICES CORP, Defendant.	*Case No. **CV 07 6434 CRB*** **EXPERT REPORT OF DR. IAN SCOTT MACKENZIE REGARDING CLAIM CONSTRUCTION OF U.S. PATENT NO. 7,109,978**

Date: July 14, 2008

Ian Scott Mackenzie

Ian Scott Mackenzie, Ph.D

1. I have been retained by Elantech Devices Corporation ("Elantech") as an expert witness regarding touchpad devices and the general subject matter and issues raised in this lawsuit relating to the patent-in-suit, U.S. Patent No. 7,109,978 ("the '978 patent"). In this expert report, I provide my opinions on the background technology and subject matter relating to the '978 patent, and how one of ordinary skill in the art would understand various terms in the asserted claims of the '978 patent.

I. BACKGROUND AND QUALIFICATIONS

2. Since 1999, I have been an associate professor of Computer Science and Engineering at York University, Toronto Canada. From 1992 to 1999, I was an associate professor of Computing and Information Science at the University of Guelph, Guelph, Ontario and from 1983 to 1991 I was a professor of Electronics Engineering at Seneca College, Toronto, Ontario. I hold a Ph.D. from the University of Toronto (1991), and M.Ed. degree, also from the University of Toronto (1989), a Diploma in Electronics Engineering Technology, Computer Option, from Durham College (1978), and a B.Mus. from Queen's University (1975).

3. My research and teaching are focused on human-computer interfaces, including substantial research with pointing and touch sensor input devices. As a consequence of my research, I have designed and analyzed numerous touch sensor input devices, and I am intimately familiar with the technological issues and state of the art in this field from the mid-1980s until the present. I have over 100 peer-reviewed research publications, many relating to pointing- or touch-based user interfaces or to microcontrollers. A copy of my current CV is attached hereto as **Exhibit A**.

4. I have been asked to give my opinion regarding the background technology and subject matter relating to the '978 patent, and how one of ordinary skill in the art would understand various terms in the asserted claims of the '978 patent. In formulating my opinions regarding the '978 patent, I have reviewed the '978 patent, its file history, and the cited references, including information and knowledge I have gained in my over 30 years of experience in the touchpad technology field. A list of the documents and references I have reviewed is provided in **Exhibit B**.

5. For purposes of this declaration, I provide my opinions based on how one of ordinary skill in the art would understand touchpads and the subject matter of the '978 patent. Based on over 30 years of experience in the field of human-computer interfaces and my review of the '978 patent, it is my opinion that one of ordinary skill at the time of the invention of the asserted patents would have at least:

(1) an undergraduate degree in Electrical Engineering or Computer Science and at least four years of experience in human-computer interface issues; or

(2) a master's degree in Electrical Engineering or Computer Science and at least two years of experience in human-computer interface issues.

II. THE '978 PATENT

A. Background

6. The '978 patent (**Exhibit C**), entitled "Object Position Detector With Edge Motion Feature and Gesture Recognition," issued from an application that is a continuation application in a chain of continuation and continuation-in-part applications dating back to 1992. This family of patent applications include U.S. Patent Nos. 5,543,591 ("the '591 patent") and 5,880,411 ("the '411 patent"), which I have previously reviewed for another lawsuit involving with Elantech and Synaptics. The '978 patent shares the same disclosure as the '411 patent and much of the same disclosure as in the '591 patent.

7. The earlier '591 patent and '411 patent were directed mainly to methods for recognizing various single-finger gestures such as taps, double taps, and drag gestures. These single finger gestures correspond to simulated mouse button actions such as clicks, double clicks, and click and drag. The disclosures of these earlier patents (as well as that of the '978 patent) include a short description of a two-finger gesture called a second-finger tap, in which one finger remains resting on a touchpad while another finger taps to one side of the primary finger. A zigzag processor is described for recognizing this second-finger tap. No other two-finger gestures are described in the '978 patent.

8. The asserted claims 1-4, 6, 8-11, and 13, 16, and 18 of the '978 patent are directed to detecting a second-finger tap. In order to detect the second-finger tap, the '978 patent discloses simultaneously measuring capacitances of sensor traces on the touchpad in order to

create a so-called "capacitance profile." '978 patent at 6:49-7:20; 12:27-13:61; 46:14-47:9. A weighted average of all the capacitances in one dimension is computed to determine the so-called "centroid," which gives the location of the finger in that dimension. *Id.* When a first finger is present on the touchpad, the centroid is computed and a first position is determined. *Id.* When a second finger touches down on the touchpad, there is an apparent rapid shift in the centroid to a second position, and when the second finger is lifted off, there is an apparent rapid shift in the centroid back to the first position. *Id.* at 46:46-49:67. These apparent shifts in position resemble a "zigzag" motion-hence the name of the zigzag processor.

B. Claimed Invention

9. Claim 1 is an independent method claim from which claims 2-3, 8, 16, and 18 depend. Claim 4 is an independent apparatus claim from which claims 6 and 9 depend. Claim 10 is an independent apparatus claim from which claims 11 and 13 depend. Claim 1 (reproduced below) is representative:

> 1. A method of processing a user input received on a capacitive touch sensor pad including a matrix of X and Y conductors, the method comprising the steps of:
>
> developing capacitance profiles in one of an X direction and a Y direction from said matrix of X and Y conductors, said capacitance profiles identifying a simultaneous presence of at least two user input objects on said capacitive touch sensor pad;
>
> examining said capacitance profiles to determine an occurrence of a single gesture resulting from the simultaneous presence of the at least two user input objects; and
>
> indicating the occurrence of said single gesture resulting from said simultaneous presence of the at least two user input objects.

Id. at 53:35-49.

III. CLAIM CONSTRUCTION

A. The meaning of "developing capacitance profiles"

10. The phrase "developing capacitance profiles" is recited in claim 1, while the phrase "develop a first capacitance profile" is recited in claim 4, and the phrase "develop at least

one capacitance profile" is recited in claim 10. Important to the meaning of these phrases is an understanding of the meaning of the term "capacitance profile" to one of ordinary skill.[1]

11. In the context of the '978 patent, one of ordinary skill in the art would understand that a "capacitance profile" is a curve formed by a complete set of capacitance measurements. The '978 patent describes that "the capacitive information from the sensing process provides a profile of the proximity of the finger" (7:3-5) and elsewhere discloses that the sensor traces are scanned and that "the scanned information provides a profile of the finger proximity in each direction." (12:29-31). It also describes "a profile of the finger" as "a complete set of sampled points [of capacitance]" (6:54-56), (6:58-60). The "sensor trace profile" is described as having characteristics including width and shape (47:7), indicating that it is a curve.

12. The '978 patent teaches developing these capacitance profiles as an important feature of the invention. According to the '978 patent, the sensor traces are scanned simultaneously (6:49-7:5), (12:35-59), or in other words, "[T]he X and Y matrix nodes are driven and sensed in parallel" (12:27-28). The '978 patent describes the requirement of scanning the traces simultaneously to overcome a problem with prior art approaches that do not scan in parallel (13:42-61). According to the inventors of the '978 patent, simultaneously scanning the traces overcomes the problem of large amplitude noise that is coupled to the circuit via the touching object (13:47-48). Indeed, the inventors stated as an object of the invention that "all row electrodes are sensed simultaneously, and all column electrodes are sensed simultaneously." (4:58-60). Consistent with the teachings in the '978 patent, in my opinion, one of ordinary skill in the art would understand "developing capacitance profiles" to mean "simultaneously measuring the capacitance on all sensor traces in an X direction or a Y direction."

---

[1] Apart from the claims, the specification of the '978 patent does not use the term "capacitance profile." Instead, the specification refers to the following: (1)"a profile of the finger" (6:55), (6:60); (2) "a profile of the proximity of the finger" (7:4-5); (3) "a profile of the finger proximity" (12:30); (4) "the profile curve of proximity" (12:33-34); (5) "the finger profile" (13:50); and (6) "the sensor trace profile" (47:7-8).

B. The meaning of "identifying a simultaneous presence of at least two user input objects"

13. The phrase "identifying a simultaneous presence of at least two user input objects developing capacitance profiles" is recited in claim 1. Consistent with the teachings in the '978 patent, in my opinion, one of ordinary skill in the art would understand this phrase to mean "recognizing a second-finger tap." A "second-finger tap" is a two-finger gesture in which one finger remains resting on the pad while another finger taps to one side of the primary finger.

14. The '978 patent describes a specific way of determining the simultaneous presence of two objects (e.g., fingers) on the touchpad. The zigzag processor 282 of FIG. 14 "decodes a two-finger gesture in which one finger remains resting on the pad while another finger taps to one side of the primary finger" (46:46-48). The zigzag processor is so named because when a second finger touches the touchpad and then lifts off, sudden cursor motions first to one side and then back again are reported to the host (46:46-61). As admitted by the inventors, "a second finger tap cannot be reliably recognized until the second finger is lifted" (46:57-58). The "zigzag" cursor motions reported to the host must be cancelled by a motion-reversal mechanism to ensure that a virtual button click occurs at the correct location (46:57-63).

15. There is a reason that the second-finger tap is the only two-finger gesture described in the '978 patent, and the reason is that the second-finger tap is the only two-finger gesture that can be recognized by the disclosed invention. As admitted by the inventors of the '978 patent, the position sensor "can only report the position of one object on its sensor surface" (7:13-14). If more than one object is present, the position sensor computes the centroid position of the combined set of objects (7:14-17). Thus, it would not be possible to recognize other two-finger gestures requiring reporting the position of both fingers using the invention disclosed in the '978 patent.

C. The meaning of "examining said capacitance profiles to determine an occurrence of a single gesture"

16. The phrase "examining said capacitance profiles to determine an occurrence of a single gesture" is recited in claim 1, while the phrase "examine said first capacitance profile" is recited in claim 4, and the phrase "examine said at least one capacitance profile" is recited in

claim 10. Consistent with the teachings in the '978 patent, in my opinion, one of ordinary skill in the art would understand the phrase "examining said capacitance profiles" to mean "computing the centroid and pressure information and comparing (X, Y, Z) values to recognize a second-finger tap."

17. The '978 patent describes only one example of any examination or processing of profiles. Specifically, examining the profiles involves deriving a digital value representing the centroid for X and Y position and a digital value representing the Z pressure information (7:6-12); (12:31-34). These values are used by the zigzag processor to recognize a second-finger tap (47:3-49:67).

D. The meaning of "single gesture resulting from the simultaneous presence of the at least two user input objects"

18. The phrase "single gesture resulting from the simultaneous presence of the at least two user input objects" is recited in claim 1, while the phrase "single gesture resulting from the simultaneous proximity of at least two input objects" is recited in claim 4, and the phrase "single gesture resulting from the simultaneous proximity of at least two user input objects" is recited in claim 10. Consistent with the teachings in the '978 patent, in my opinion, one of ordinary skill in the art would understand the phrase "single gesture resulting from the simultaneous presence of the at least two user input objects" to mean "a second-finger tap." As explained above, the second-finger tap is the only two-finger gesture that is described in the '978 patent and is the only two-finger gesture that can be recognized by the disclosed invention.

E. The meaning of "indicating the occurrence of said single gesture"

19. The phrase "indicating the occurrence of said single gesture" is recited in claim 1, while the phrase "indicate the occurrence of said single gesture" is recited in claim10. Consistent with the teachings in the '978 patent, in my opinion, one of ordinary skill in the art would understand the phrase "indicating the occurrence of said single gesture" to mean "indicating the occurrence of a second-finger tap."

20. As explained above, the only two-finger gesture described in the '978 patent is the second-finger tap. One of ordinary skill in the art would understand the "said single gesture" to

mean a second-finger tap. The '978 patent describes the zigzag unit 282 which recognizes second-finger taps. A leftward zigzag may be used to simulate a left mouse button click and a rightward zigzag may be used to simulate a right mouse button click (47:21-23). As described by the inventors, the output of the zigzag unit is one of "LEFT, RIGHT, or NONE" (47:39-40).

F. The meaning of "signal representing a simulated mouse button click"

21. The phrase "signal representing a simulated mouse button click" is recited in claim 2, while the phrase "signal representing a simulated mouse action" is recited in claims 11 and 16. Consistent with the teachings in the '978 patent, in my opinion, one of ordinary skill in the art would understand the phrase "signal indicating a simulated mouse button click" to mean "a value of LEFT or RIGHT denoting a second-finger tap."

22. As explained above, the '978 patent describes the zigzag unit 282 which recognizes second-finger taps. A leftward zigzag may be used to simulate a left mouse button click and a rightward zigzag may be used to simulate a right mouse button click (47:21-23). As described, the output of the zigzag unit is one of "LEFT, RIGHT, or NONE" (47:39-40).

IV. <u>CONCLUSION</u>

23. Based on my analysis, it is my opinion the above claim terms in the asserted claims 1-4, 6, 8-11, and 13, 16, and 18 of the '978 patent should be construed in the manner set forth in this report.

24. I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

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JUL 31 2008

MORRISON & FOERSTER LLP

Yitai Hu (SBN 248085) (yhu@akingump.com)
Sean P. DeBruine (SBN 168071) (sdebruine@akingump.com)
S.H. Michael Kim (SBN 203491) (mkim@akingump.com)
Richard Chae (SBN 224610) (rchae@akingump.com)
AKIN GUMP STRAUSS HAUER & FELD LLP
3000 El Camino Real, Suite 400
Palo Alto, California 94306
Telephone: 650-838-2000
Facsimile: 650-838-2001

Attorneys for Plaintiff and Counter Defendant
ELANTECH DEVICES CORPORATION

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

SYNAPTICS, INCORPORATED,

Plaintiff,

vs.

ELANTECH DEVICES CORP,

Defendant.

Case No. **CV 07 6434 CRB**

REBUTTAL EXPERT REPORT OF DR. IAN SCOTT MACKENZIE REGARDING CLAIM CONSTRUCTION OF U.S. PATENT NO. 7,109,978

Date: July 30, 2008

Ian Scott MacKenzie

Ian Scott MacKenzie, Ph.D

I. INTRODUCTION

1. I submit this Rebuttal Expert Report on behalf of Elantech Devices Corporation ("Elantech") concerning U.S. Patent No. 7,109,978 ("the '978 patent"). I understand that Synaptics has submitted in this lawsuit the Expert Report prepared by Dr. Andrew Wolfe concerning claim construction of the '978 patent ("Dr. Wolfe's Report"). I have been asked to address certain issues relating to the '978 patent and technology at issue and the claim construction given for certain terms in Dr. Wolfe's Report.

2. As set forth in my analysis below, I disagree with Dr. Wolfe's claim construction for various terms and his understanding of the '978 patent. Dr. Wolfe improperly construed certain terms outside the context of the '978 patent, and I therefore find those claim construction positions to be improper. For Elantech, in my opening Expert Report, I have set forth the proper construction of the terms in view of the '978 patent, including support in the '978 patent for my claim construction positions. I incorporate that analysis herein by reference.

II. SCOPE AND PREPARATION OF REBUTTAL REPORT

3. In this Rebuttal Expert Report I set forth my opinions and conclusions on why I disagree with a number of conclusions made by Dr. Wolfe, including his claim construction of various terms and understanding of the technology at issue. In forming my opinions and conclusions, I rely on my knowledge and over 30 years of experience in the field of human-computer interfaces, including touchpad devices. I also rely on the documents and information listed below, as well as information and references cited in Dr. Wolfe's Report.

- the '978 patent, its file history, and cited references;
- the '591 patent and its file history;
- the '411 patent and its file history;
- the '931 patent and its file history;
- Excerpts from *The IEEE Standard Dictionary of Electrical and Electronic Terms* (SYNAP0001441-0001445);
- Excerpts from the Modern Dictionary of Electronics (SYNAP0001445-1452);

- Dr. Wolfe's Expert Report Concerning Claim Construction of '978 patent and cited exhibits; and
- Synaptics Preliminary Patent Local Rule 4-2 Disclosures.

4. I understand that discovery in this Investigation is ongoing and that depositions and documents related to issues addressed in this report may be produced after my report has been served. For example, it is my understanding that the inventors of the '978 patent have not been deposed. Accordingly, I may supplement this report as additional information becomes available to me.

III. <u>LEVEL OF ORDINARY SKILL</u>

5. As stated in my opening Expert Report concerning claim construction of the '978 patent, I expressed my opinion that the level of ordinary skill at the time of the invention of the asserted patents would have at least: (1) an undergraduate degree in Electrical Engineering or Computer Science and at least four years of experience in human-computer interface issues; or (2) a master's degree in Electrical Engineering or Computer Science and at least two years of experience in human-computer interface issues. Based on this level of ordinary skill, I gave my opinions on interpreting terms in the '978 patent. In his report at ¶ 10, Dr. Wolfe's opinion on the level of ordinary skill is essentially the same as mine, and I will assume there is no dispute on the level of ordinary skill.

IV. <u>TECHNOLOGY AND BACKGROUND</u>

6. I now address certain concepts that are important to understand differences between prior art capacitance touch pad devices and the claimed invention disclosed in the '978 patent. These differences provide important insights on how various terms claimed in the '978 patent should be understood.

7. First, in the Background section of the '978 patent, prior art two-dimensional capacitance systems were discussed for touch pad devices, *See, e.g.*, U.S. Patent Nos. 4,550,221 and 4,733,222 to Mabusth and Evans, respectively, and PCT Application No. 90/04584 to Gerpheide. (2:41-3:58). These prior art devices sensed capacitance values at various points on rows of electrodes and columns of electrodes of a matrix. A shortcoming with these prior art

systems is that they used only one set of driving and sensing electronics, which was multiplexed sequentially over the electrodes in the device. (4:3-6). In other words, row and column electrodes were sensed one at a time. As a result, according to the '978 patent, this sequential scanning approach "made them more susceptible to noise," that is, "[n]oise levels could change between successive measurements . . ." (4:10-14). The inventors recognized this problem and emphasized for their invention sensing all row and column electrodes **simultaneously** instead of one at a time to avoid noise:

> *It is thus an object of the present invention* to provide a two-dimensional capacitive sensing system equipped with a separate set of drive/sense electronics for each row and for each column of a capacitive tablet, wherein all row electrodes are sensed simultaneously, and all column electrodes are sensed simultaneously.

(4:55-60)(emphasis in original text).

8. This parallel-sensing capability was made possible by the claimed invention using one set of electronics per row or column, which "allows the sensing cycle to be extremely short, thus allowing fast response while still maintaining immunity to very high levels of electrical interference." (5:49-53). In the Detailed Description of the '978 patent, all of the embodiments required capacitance measurements be made simultaneously each in the X direction and Y direction to overcome the above shortcomings of the prior art:

> According to a presently preferred drive/sense method used in the present invention, the capacitance measurements are performed simultaneously across all inputs in one dimension to overcome a problem that is inherent in all prior art approaches that scan individual inputs. The problem with the prior-art approach is that it is sensitive to high frequency and large amplitude noise (large dv/dt noise) that is coupled to the circuit via the touching object. Such noise may distort the finger profile because of noise appearing in a later scan cycle but not an earlier one, due to a change in the noise level.
>
> The present invention overcomes this problem by "taking a snapshot" of all inputs simultaneously in X and then Y directions (or visa versa). Because the injected noise is proportional to the finger signal strength across all inputs, it is therefore symmetric around the finger centroid. Because it is symmetric around the

> finger centroid it does not affect the finger position. Additionally, the charge amplifier performs a differential measuring function to further reject common-mode noise.

(13:41-60)(emphasis added).

9. Using one set of drive and sense electronics per row or column afforded other benefits over the prior art systems. Other shortcomings of the prior art included the inability to provide a fast pointing device as well as the inability to offer simple and inexpensive drive and sense electronics. The described invention relies on driving and sensing to occur on the same line for each row or column. This allows independent calibration of all signal paths, resulting in simpler board layout. (3:47-4:6).

10. Thus, based on at least these passages of the '978 patent, one of ordinary skill would understand that noise was a problem that the inventors wanted to avoid for their invention. To do this, the inventors designed a device to take capacitance measurements simultaneously in each of the X and Y directions instead of the prior art way of sequentially taking capacitance measurements for each column in the X direction and each row in the Y direction. This device, as described in the '978 patent, uses one set of drive and sense electronics per row or column and simultaneously measures the capacitance in each of the X and Y directions. That is, the capacitance on all columns is measured at once to determine the capacitance in the X direction and the capacitance on all rows is measured at once to determine capacitance in the Y direction. Thus, in my opinion, for the claimed invention, sequentially taking capacitance measurements is not a method covered by the '978 patent.

V. <u>CLAIM CONSTRUCTION</u>

A. General Objections

11. I have reviewed Dr. Wolfe's proposed construction of the claim terms found in his report and have substantial disagreements with most of them. His proposed constructions suffer from three general failures. First, Dr. Wolfe simply ignores or reads words out of a claim, *e.g.*, in giving "capacitance profiles" a meaning, he ignores how "profiles" is used in the patent and replaces it with "information." It is my understanding that claims are read in the context of the patent. The specification of the '978 patent does not refer to profiles as information, but as a

curve based on capacitance measurements. Second, Dr. Wolfe fails to consider the shortcomings of the prior art and how the claimed invention senses all row and column electrodes simultaneously instead of prior art way – *i.e.*, sequentially or one at a time. Third, Dr. Wolfe interprets terms outside the scope of the '978 patent. Therefore, I do not believe that one skilled in the art would apply his definitions to certain claim terms he has construed.

12. Although I may not address every statement or conclusion given by Dr. Wolfe in his report, it should not be taken that I necessarily agree with them. I now provide my specific objections to various terms construed by Dr. Wolfe in his report.

B. Specific Objections

1. "Gesture"

13. It is my understanding that Elantech does not believe this term should be construed alone, but should be construed as part of a larger phrase in which it is used in the claims. Dr. Wolfe construed "gesture" alone to mean "finger or object action that communicates input to a device." Dr. Wolfe's Report at ¶ 14. The term "gesture" in isolation is well known, which simply refers to an action of a finger or object, either on a surface or in the air. Dr. Wolfe's construction is not entirely accurate. The finger or object action is not communicating input *per se*. Rather, it is the finger or object action that is interpreted to communicate an input. The location, movement, and pressure applied of a finger or object on a touch sensitive surface is what is detected. In the context of the '978 patent, X and Y matrix nodes simultaneously detect capacitances and generate "capacitance profiles." These matrix nodes then communicate the capacitance profiles to an arithmetic logic unit for processing. (12:60-14:63). Thus, I disagree with "that communicates input to a device" part of Dr. Wolfe's definition of "gesture."

2. "Capacitance Profile"

14. Dr. Wolfe defines the term "capacitance profile" as "capacitance information on conductive lines." I disagree with Dr. Wolfe because he ignores the word "profile" and replaces it with "information." As I explained in my opening report, the '978 patent does not associate "profile" with merely information, but rather associates it with a curve. *See* Dr. MacKenzie Expert Report at ¶ 11. Furthermore, Dr. Wolfe's proposed construction does not clarify the

meaning. The simple substitution of the word "information" for "profiles" does not aid a skilled artisan in interpreting this term. Accordingly, I do not believe one of ordinary skill would equate "profiles" with "information" based on the clear teachings in the '978 patent.

15. In my opening Expert Report, I explained that the term "capacitance profile" would be understood by one of ordinary skill in the art to mean "a curve formed by a complete set of capacitance measurements" because that is how the term is described in the '978 patent. For example, the '978 patent expressly refers to "profile" as a curve having X and Y dimensions:

> The scanned information provides a <u>profile</u> of the finger proximity in each dimension. According to this aspect of the invention, the <u>profile</u> centroid is derived in both the X and Y directions and is the position in that dimension. The <u>profile</u> <u>curve</u> of proximity is also integrated to provide the Z information.

(12:29-34)(emphasis added). The '978 patent also refers to "a profile of the finger" as "a complete set of sampled points [of capacitance]" (6:54-56), and a "sensor trace profile" as having characteristics including width and shape (47:7), indicating that it is a curve. Based on at least these statements, one of ordinary skill would understand a "capacitance profile" to be a curve formed by a complete set of capacitance measurements, not just capacitance information.

16. In addition, with reference to ¶ 17 of Dr. Wolfe's report, Dr. Wolfe stated that "[I]t is advantageous to aggregate the individual capacitive information" into a "collection," but later asserts that the '978 patent does not limit this term to apply to a complete set of information. This is nonsensical, because one purpose of developing a capacitance profile is to determine the location of the finger anywhere on the touchpad surface. In order to do this, the capacitive measurements on all traces must be taken into account.

3. "Developing Capacitance Profiles"

17. I disagree with Dr. Wolfe's construction for "developing capacitance profiles," "develop a first capacitance profile," and "develop at least one capacitance profile" because it is inconsistent with the '978 patent. Dr. Wolfe defines these terms as "sensing and quantifying capacitive information on conductive lines."

18. This construction is too broad because it can cover a method of developing capacitance values that is criticized and avoided in the '978 patent. For example, as noted above in Section IV of this rebuttal report, the inventors identified susceptibility to noise as a shortcoming in the prior art way of developing capacitance profiles, *i.e.*, sequentially sensing capacitance (or one at a time) on each row or column electrode. (4:10-14). To avoid this noise problem, the inventors emphasized providing a two-dimensional capacitive sensing system equipped with a separate set of drive/sense electronics for each row and for each column so that all row electrodes are **sensed simultaneously**, and all column electrodes are **sensed simultaneously** – *i.e.*, parallel sensing capability. (4:55-60). By sensing the rows or columns simultaneously, noise could be reduced due to fast sensing and response times allowing for high immunity to electrical interference. (5:49-53). This is a critical feature of the invention. In fact, the inventors specifically required the claimed embodiments for "'<u>taking a snapshot</u>' of <u>all inputs simultaneously in X</u> and then <u>Y directions</u> (or vice versa)" to overcome this shortcoming in the prior art way of sequentially developing capacitance profiles. (13:53-55).

19. Thus, consistent with the '978 patent, in my opinion, one of ordinary skill, when reading the above-noted statements by the inventors about the shortcomings of the prior art and the express statements of sensing all row and column electrodes simultaneously to overcome those shortcomings for their invention, would conclude that "developing capacitance profiles" can only mean "simultaneously measuring the capacitance on all sensor traces in an X direction and Y direction."

20. In addition, at ¶ 20 of his report, Dr. Wolfe refers to a "second drive/sense method" (6:49-7:5) to infer that not all embodiments of invention require "*all* traces in a particular direction be measured *simultaneously*." Specifically, regarding this second method, Dr. Wolfe concludes that ". . . the second described method only mentions moving the line voltages simultaneously. The second method makes no mention of sensing or measuring the lines simultaneously . . ." That is not what the passage says and no one of ordinary skill would read it that way. The '978 patent expressly describes that voltages on all X and Y lines of the sensor matrix are **simultaneously** moved in a positive and negative direction. The only

difference between the first and second embodiments is that in the first embodiment, voltages on the X lines are held constant while voltages on the Y lines are simultaneously moved (and vice versa), whereas in the second embodiment, the voltages on X lines are simultaneously moved in one direction while the voltages on the Y lines are simultaneously moved in an opposite direction. The effect of moving the voltages on both the X and Y lines in the second embodiment is to accentuate transcapacitance between the two dimensions and to de-emphasize virtual ground parasitic capacitance. (12:55-56). Thus, contrary to Dr. Wolfe's conclusion, the passage supports my construction that all traces in an X direction and Y direction (positive or negative) are sensed simultaneously.

4. "Identifying the simultaneous presence of at least two user input objects"

21. Dr. Wolfe construes the above term as "determining that two objects or fingers are on or near the touch pad." Dr. Wolfe's Report at ¶ 21. I disagree with this term because it goes beyond the scope of the '978 patent. As I have explained at ¶ 13-15 in my opening Expert Report, the only two-object gesture that is taught by the '978 patent is the second-finger tap. This is a two-finger gesture in which one finger remains resting on the pad while another finger taps to one side of the primary finger. The '978 patent does not teach how to recognize any other two-object gesture, and only discloses a zigzag processor 282 (FIG 14) designed to detect only a second-finger tap. The zigzag processor cannot detect any other two-object gestures. Indeed, the name of the zigzag processor derives from the apparent zigzag motion involved in recognizing a second-finger tap after the second finger has been removed. In my opinion, one of ordinary skill, when interpreting the above term in the context of the '978 patent, would understand this term to mean "recognizing a second-finger tap."

22. As I explained in my opening report, the zigzag processor computes a "centroid," which is a weighted average of all the capacitances in one dimension. When a first finger is present on the touchpad, the centroid is computed and a first position is determined. *Id.* When a second finger touches down on the touchpad, there is an apparent rapid shift in the centroid to a second position, and when the second finger is lifted off, there is an apparent rapid shift in the

centroid back to the first position. *Id.* at 46:46-49:67. I note that only one centroid is computed at a time, and at the time the second finger touches down, the zigzag processor cannot recognize that more than one finger is presently on the touchpad. At the time the second finger touches down, the actual shift in the centroid could be interpreted to represent something other than the presence of a second object. For example, a shift in the centroid could represent an object motion or an increase in the size of the first object (47:66-48:1 "the first half of the zigzag gesture in which the apparent finger grows and jumps to one side.") As admitted by the inventors, the position sensor "can only report the position of one object on its sensor surface" (7:13-14). It is only when the second finger lifts off that the zigzag processor can recognize that a second finger was present. As plainly admitted by the inventors, a second-finger tap "cannot be reliably recognized until the second finger is <u>lifted</u>." (46:57-58). As such, there is no support in the '978 patent for Dr. Wolfe's construction of determining that two objects or fingers are <u>presently</u> on the touch pad.

23. In addition, at ¶ 22 of his opening report, Dr. Wolfe incorrectly asserts that the '978 patent teaches how to recognize other multiple-object gestures. This is simply not true. Dr. Wolfe first asserts that two objects can be present simultaneously without the second finger being tapped. Dr. Wolfe ignores the simple fact that the '978 patent, including the cited passages, does not disclose how to <u>recognize</u> such a gesture. Instead, Dr. Wolfe can only claim that the '978 patent "discusses one way to <u>measure</u> the presence of two fingers on the pad at the same time" by reporting the apparent position midway between the two fingers. <u>Measuring the presence</u> of two fingers is not the same as <u>recognizing the presence</u> of two fingers. A simple analogy is illustrative. A scale for measuring mass can <u>measure</u> the presence of two objects present on the scale at the same time, but the scale cannot <u>recognize</u> the presence of two objects. Dr. Wolfe also incorrectly relies on the following passage: "When a second finger comes down on the pad, the (X, Y, Z) values typically take two or three samples to converge to their new values which reflect the presence of two fingers." In fact, the new (X, Y, Z) values can be interpreted to reflect something other than the presence of a second finger, and it is only after the second finger is lifted that the zigzag processor can recognize that a second finger <u>had been present</u> – not that a

second finger <u>is presently on</u> the touchpad. The remaining passages cited by Dr. Wolfe refer generically to multiple-finger gestures, but none of these other gestures are ever described in any embodiments, nor is there any disclosure sufficient to enable one of ordinary skill in the art to implement recognition of any other multiple-object gestures.

24. Also at ¶ 22 of his opening report, Dr. Wolfe incorrectly states that Elantech's proposed construction would encompass the "hop" gesture. This is simply not the case. In my opening report, I described that a second-finger tap is a two-finger gesture in which one finger remains resting on the pad while another finger taps to one side of the primary finger. Indeed, this definition comes straight from the '978 patent itself (46:46-48). In my opinion, one of ordinary skill in the art would understand that "recognizing a second-finger tap" would not include recognizing the "hop" gesture.

25. Finally, at ¶ 23 of his opening report, Dr. Wolfe states that the same phrase "simultaneous presence" is used in Elantech's '352 patent and incorrectly concludes that because Elantech's claims encompass numerous multiple-finger gestures, then Synaptics should be afforded a similar broad construction. The claim construction for the '352 patent is based on its own disclosure, which contains an entirely different specification than that of the '978 patent. Therefore, the claim construction for the '352 patent is irrelevant and cannot apply to the '978 patent.

5. "Examining said capacitance profiles to determine an occurrence of a single gesture"

26. For the above term, I have already addressed my disagreement with Dr. Wolfe on the proper meaning for "capacitance profiles" and "gesture." I further disagree with Dr. Wolfe that the above term means "processing the capacitance profile information to determine that a gesture has occurred" because its scope goes outside the context of the '978 patent.

27. As I have explained at ¶ 16-17 in my opening Expert Report, in my opinion, the above term means "computing the centroid and pressure information and comparing (X, Y, Z) values to recognize a second-finger tap." Contrary to Dr. Wolfe's assertions, this construction is not reading in a preferred embodiment into the claims, but rather staying consistent with the

teachings of the '978 patent. Specifically, the '978 patent teaches only one way to examine capacitance profiles by deriving a digital value representing the centroid for X and Y position and a digital value representing the Z pressure information (7:6-12); (12:31-34). These values are then used by the zigzag processor to recognize only a second-finger tap (47:3-49:67). These teachings, however, do not support Dr. Wolfe's construction.

28. I also disagree with Dr. Wolfe when he opines that the "single gesture" can refer to "a variety of gestures." Clearly, this is not the case in the context of these claims, which only relate to gestures involving two or more objects – which in this case, can only refer to a second-finger tap. Additionally, Dr. Wolfe equates "examining ... profiles" with "processing ... information." This simple substitution of words offers no further clarity to the meaning of this term.

6. "Single gesture resulting from the simultaneous presence of the at least two user input objects"

29. For reasons similar to the above regarding "identifying the simultaneous presence of at least two user input objects" and explained at ¶ 18 in my opening expert report, in my opinion, the above term means "a second-finger tap." As explained above, the second-finger tap is the only two-finger gesture that is described and taught in the '978 patent and is the only two-finger gesture that can be recognized by the disclosed invention.

30. Dr. Wolfe's construction of this phrase is overly broad and not supported by the patent disclosure. At ¶ 22 of his report, Dr. Wolfe cites to various passages from the '978 patent, but these passages do no to support his claim construction positions as I have addressed at ¶¶ 23-24 above. Moreover, I note again that the '978 patent "can only report the position of one object on its sensor surface." (7:13-14). If more than one object is present, the position sensor computes the centroid position of the combined set of objects (7:14-17). Only when it detects a zigzag motion can the zigzag processor determine such a motion to be a second-finger tap. As I have previously stated, it would be impossible to recognize other two-finger gestures when reporting the position of only one object at a time. Thus, contrary to Dr. Wolfe's assertion at ¶ 26 of his opening report that "the patent provides adequate teachings to one of ordinary skill in the

art to enable the understanding of a variety of two-or-more-finger gestures," the only multiple-object gesture that can be recognized by the invention disclosed in the '978 patent is a second-finger tap.

7. "Indicating/indicate the occurrence of said single gesture"

31. I disagree with Dr. Wolfe's construction of this term as "transmitting information to another module, routine, function, or device that indicates that a gesture has occurred based on the simultaneous presence of at least two input objects" because it is too broad and beyond the scope of the '978 patent. As I have explained at ¶ 19-20 of my opening Expert Report, the proper construction of this term should be "indicating the occurrence of a second-finger tap."

32. As explained above and in my opening report, the '978 patent only teaches the recognition and indication of the occurrence of a specific two-finger gesture – *i.e.*, a second-finger tap action – and no others. For example, a leftward zigzag may be used to simulate a left mouse button click and a rightward zigzag may be used to simulate a right mouse button click (47:21-23). As described by the inventors, the outputs of the zigzag processor includes "LEFT, RIGHT, or NONE" (47:39-40). Hence, the '978 patent does not teach one of ordinary skill how to indicate any other single gesture [resulting from the simultaneous presence of at least two user input objects] besides a second-figure tap.

8. "Signal representing a simulated mouse button click"

33. I disagree with Dr. Wolfe's claim construction for this term because his definition is taken outside the context of the '978 patent and its claims. For instance, this term is associated with the occurrence of "said single gesture," which has been explained to have only one meaning – a second-finger tap. Because "said single gesture" can only mean a second-finger tap, the above term must mean "a value of LEFT or RIGHT denoting a second-finger tap." As explained above and in my opening report, in the occurrence of a second-finger tap, the '978 patent teaches that the zigzag processor 282 recognizes a leftward zigzag to simulate a LEFT mouse button click and a rightward zigzag to simulate a RIGHT mouse button click (47:21-23; 47:39-40). No other motions are described for simulating a mouse button click.

34. Referring to Dr. Wolfe's arguments at ¶ 33 of his report, the fact that the disclosed embodiments can detect other gestures besides a two-finger tap is irrelevant for purposes of claim construction because all of the asserted claims require identifying the simultaneous presence of at least two objects, which has been explained repeatedly to mean a second-finger tap. Dr. Wolfe's misleading cites to the '978 patent do not support his claim construction positions for the above term.

9. "Developing capacitance profiles in both said X and Y directions"

35. For the above term, Dr. Wolfe adopts the same construction given to "developing capacitance profiles." Therefore, I disagree with Dr. Wolfe for the same reasons noted above and in my opening report for the term "developing capacitance profiles." Thus, the proper construction for this term should be "simultaneously measuring the capacitance on all sensor traces in an X direction and Y direction."

10. "Capacitive Sensor", "Sensing Circuitry", "Configured to generate outputs based on the capacitance", "Arithmetic Unit", "Button Press"

36. For the above terms, it is my understanding that Elantech has taken the position they do not require any construction at all and have an ordinary meaning to those skilled in the art. I agree with Elantech. Nevertheless, Dr. Wolfe reads in unnecessary limitations to some of these terms. For example, Dr. Wolfe construes "capacitive sensor" to mean "a device with a plurality of conductive lines that senses capacitive information." One of ordinary skill would understand these two words in combination to simply mean a sensor that senses capacitance.

VI. <u>CONCLUSION</u>

37. Based on the clear teachings of the '978 patent, it is my opinion the proper construction for the asserted claims are set forth in my opening and rebuttal reports and that many of Dr. Wolfe's constructions should be rejected as improper for reading claims terms outside the context of the '978 patent.

EXHIBIT F

US005825352A

United States Patent [19]

Bisset et al.

[11] **Patent Number: 5,825,352**

[45] **Date of Patent: Oct. 20, 1998**

[54] **MULTIPLE FINGERS CONTACT SENSING METHOD FOR EMULATING MOUSE BUTTONS AND MOUSE OPERATIONS ON A TOUCH SENSOR PAD**

[75] Inventors: **Stephen J. Bisset**, Palo Alto; **Bernard Kasser**, Menlo Park, both of Calif.

[73] Assignee: **Logitech, Inc.**, Fremont, Calif.

[21] Appl. No.: **608,116**

[22] Filed: **Feb. 28, 1996**

Related U.S. Application Data

[63] Continuation of Ser. No. 582,768, Jan. 4, 1996, abandoned.

[51] **Int. Cl.**[6] **G09G 5/00**; G09G 5/08

[52] **U.S. Cl.** **345/173**; 345/157

[58] **Field of Search** 345/156, 157, 345/160, 173, 174, 145; 178/18; 341/33

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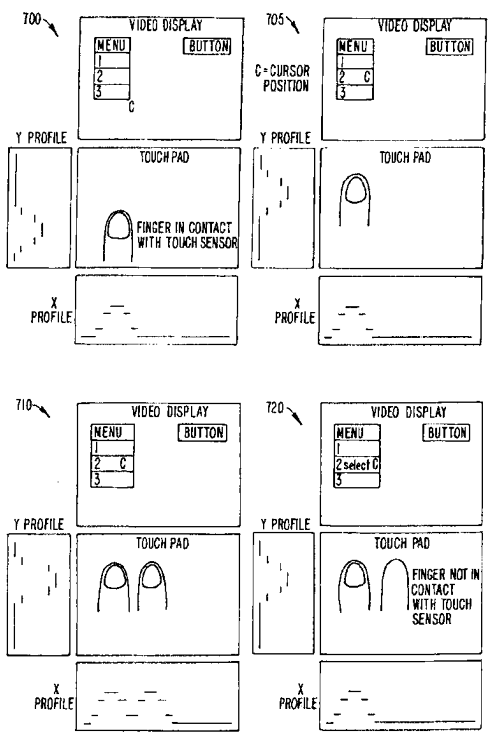
Primary Examiner—Jeffery Brier
Assistant Examiner—Paul A. Bell
Attorney, Agent, or Firm—Townsend and Townsend and Crew

[57] **ABSTRACT**

Method and apparatus for detecting an operative coupling between one or more fingers or other appropriate objects and a touch pad includes processes for detection of multiple maxima with intermediate minima in appropriate sequences to emulate the operations of cursor control and button actuations in a pointing and control device.

31 Claims, 17 Drawing Sheets



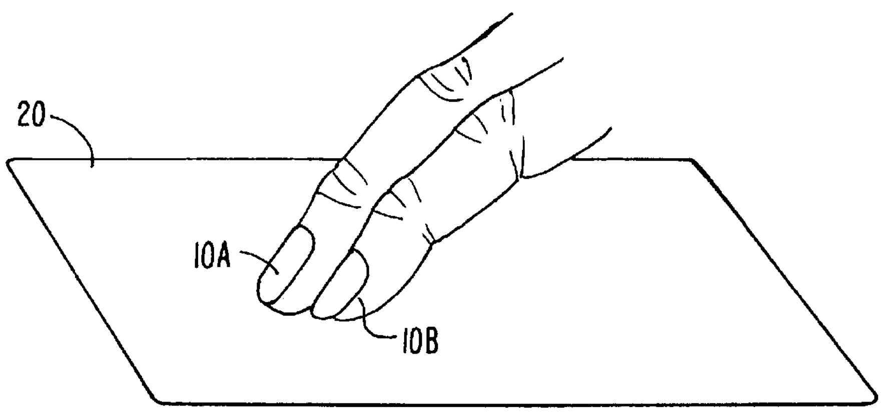


FIG. 1.

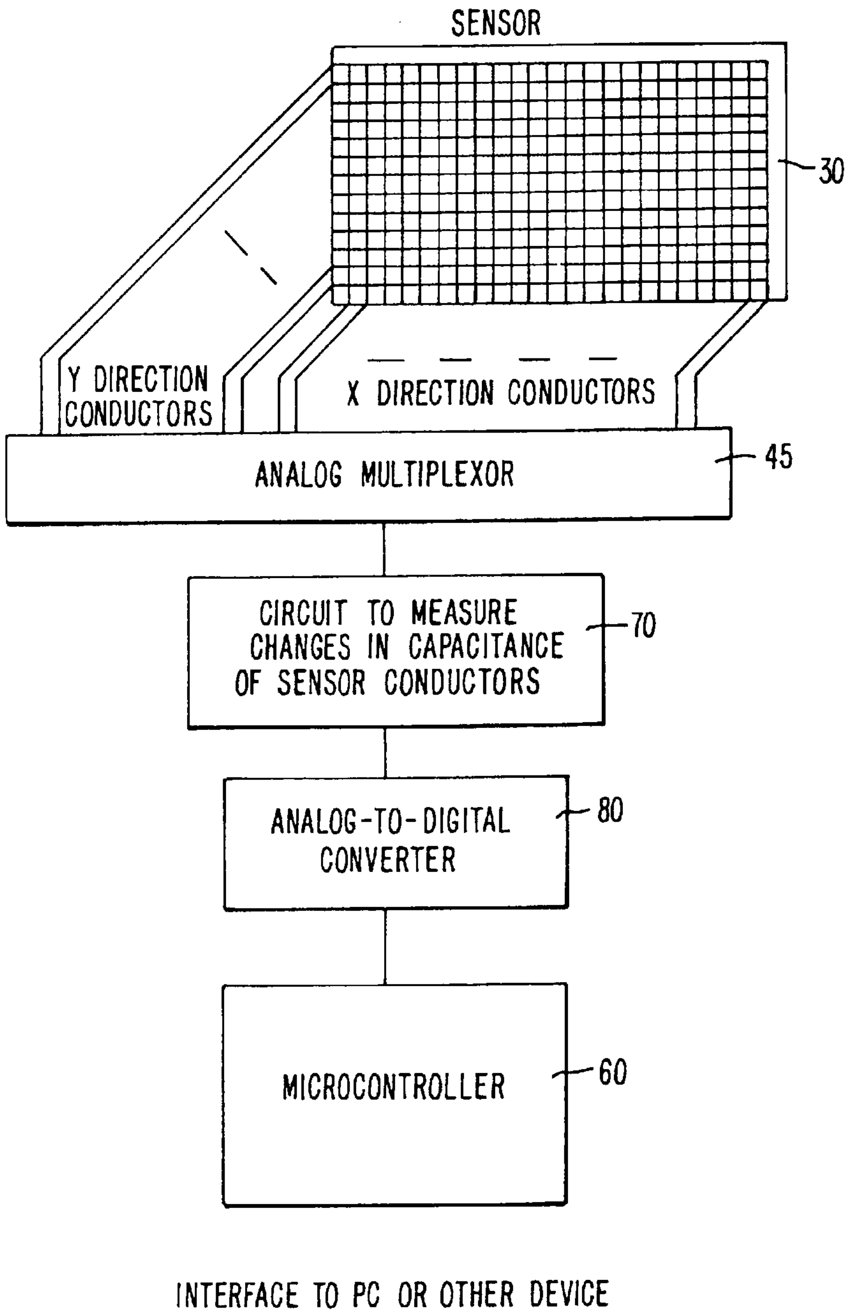

SENSOR
30
Y DIRECTION CONDUCTORS
X DIRECTION CONDUCTORS
ANALOG MULTIPLEXOR
45
CIRCUIT TO MEASURE CHANGES IN CAPACITANCE OF SENSOR CONDUCTORS
70
ANALOG-TO-DIGITAL CONVERTER
80
MICROCONTROLLER
60
INTERFACE TO PC OR OTHER DEVICE

FIG. 2.

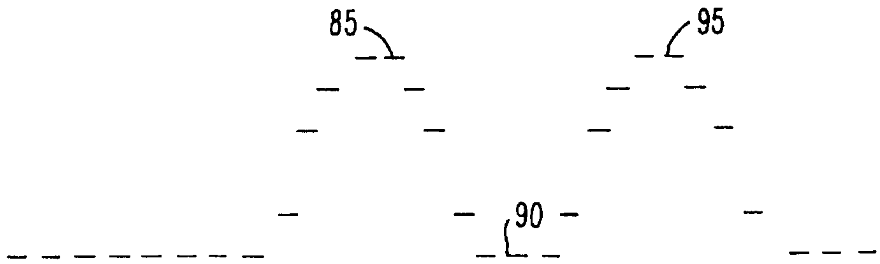


FIG. 3.

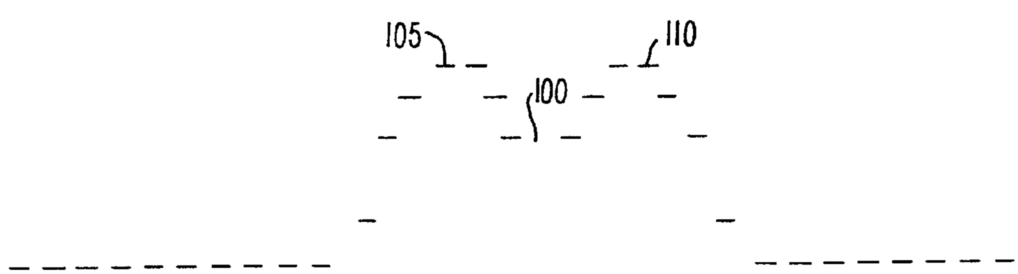
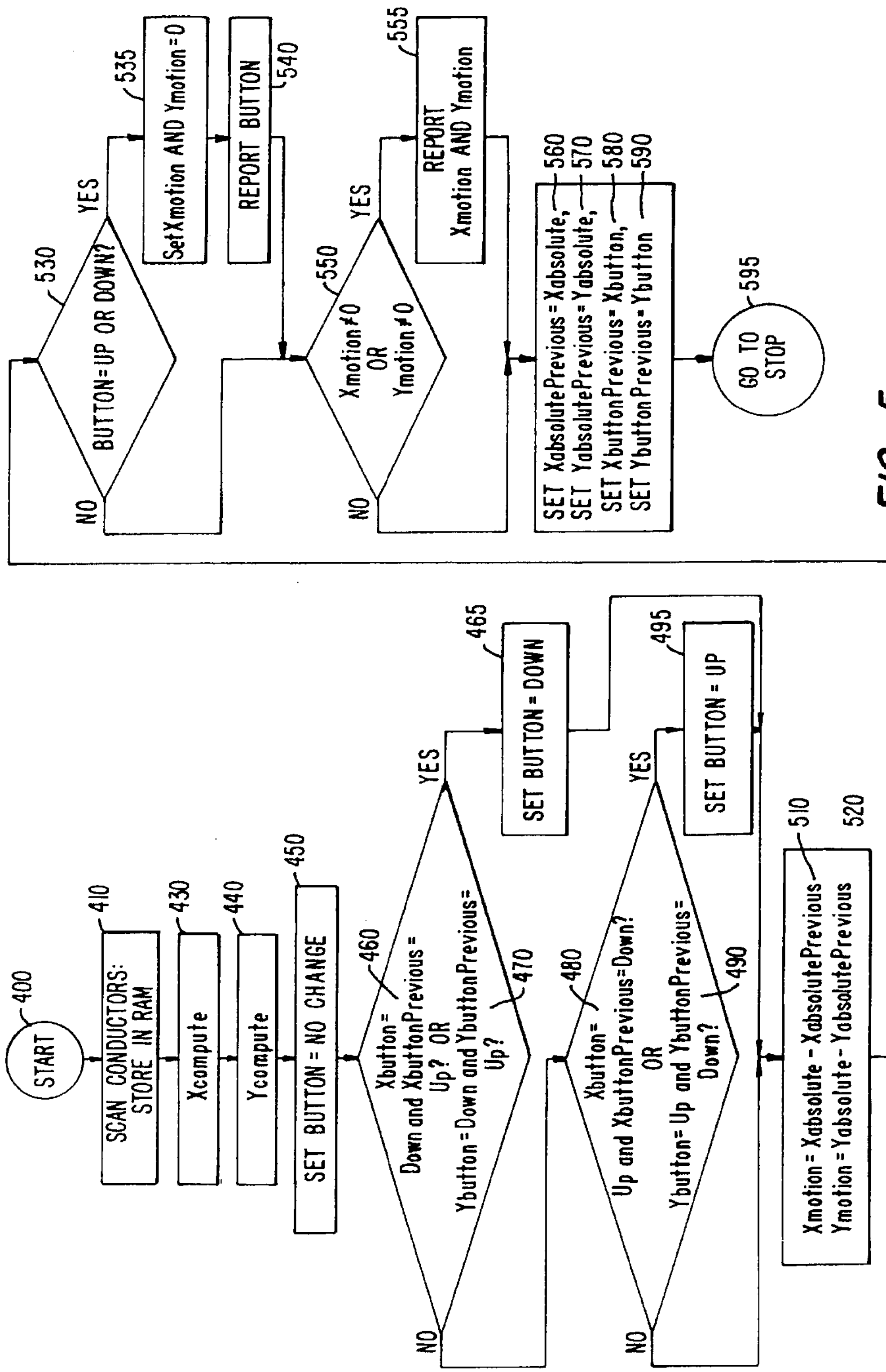
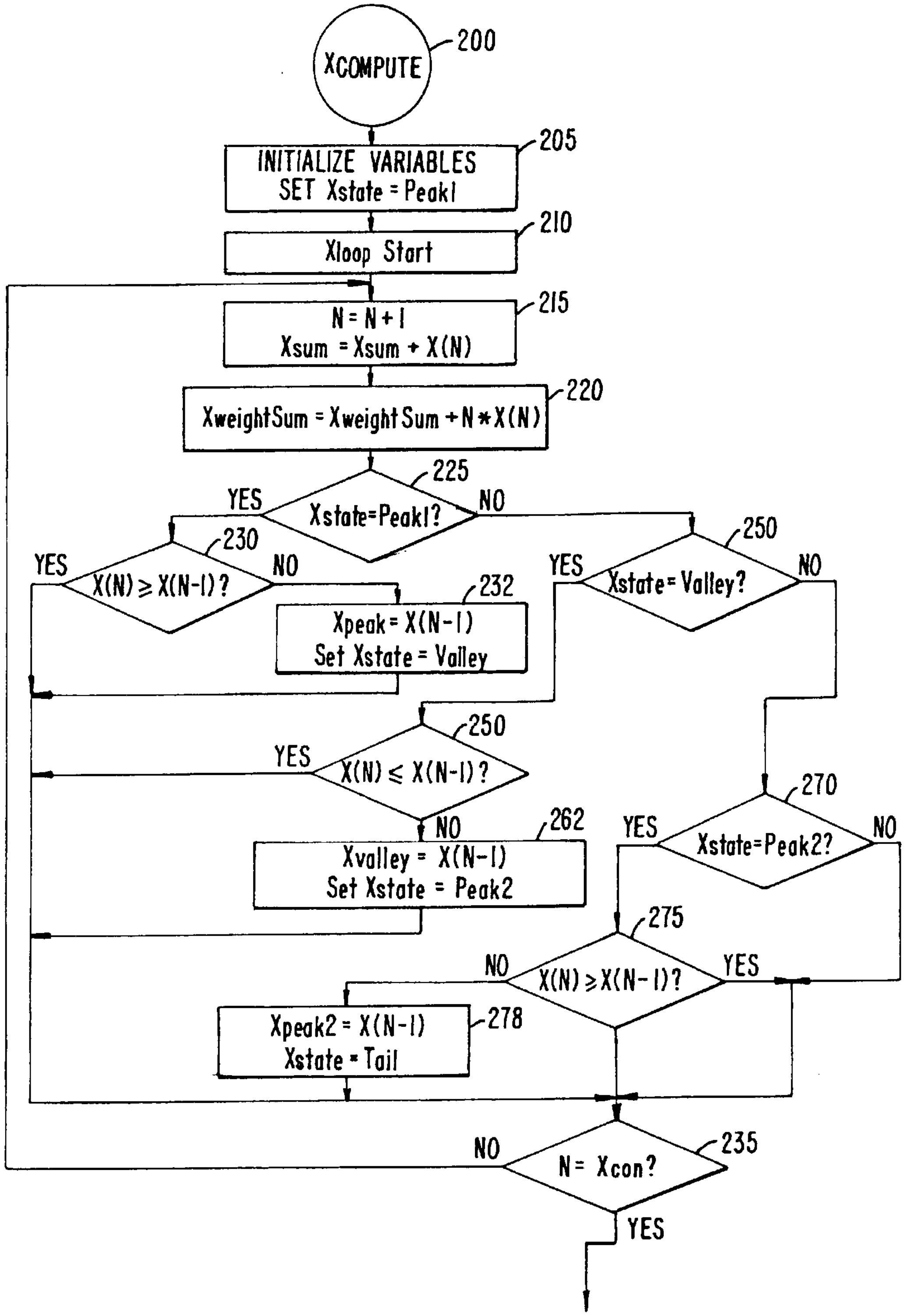


FIG. 4.



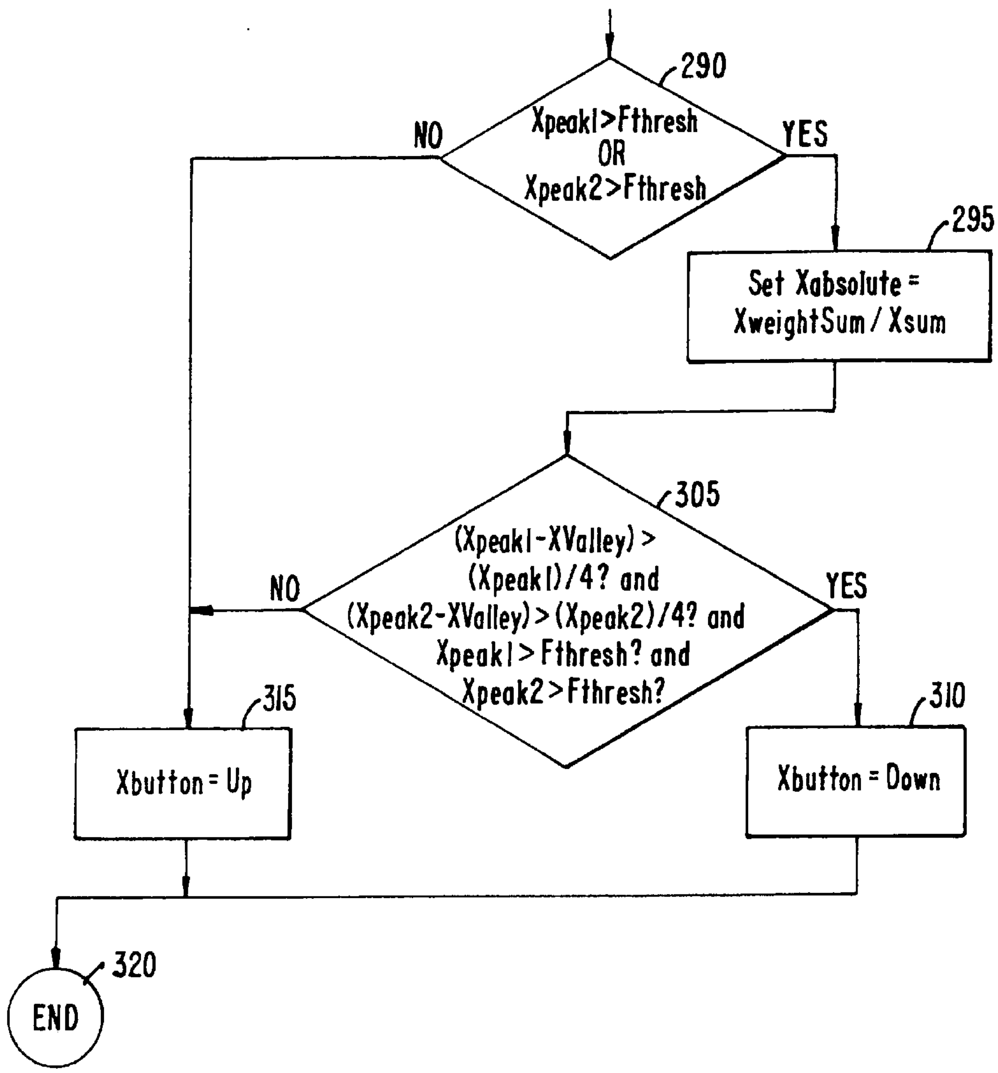
START
400
SCAN CONDUCTORS: STORE IN RAM
410
Xcompute
430
Ycompute
440
SET BUTTON = NO CHANGE
450
Xbutton= Down and XbuttonPrevious = Up? OR Ybutton=Down and YbuttonPrevious= Up?
460
470
YES
NO
SET BUTTON = DOWN
465
Xbutton= Up and XbuttonPrevious=Down? OR Ybutton= Up and YbuttonPrevious= Down?
480
490
YES
NO
SET BUTTON = UP
495
Xmotion = Xabsolute - XabsolutePrevious
Ymotion = Yabsolute - YabsolutePrevious
510
520
BUTTON=UP OR DOWN?
530
YES
NO
SetXmotion AND Ymotion=0
535
REPORT BUTTON
540
Xmotion≠0 OR Ymotion≠0
550
YES
NO
REPORT Xmotion AND Ymotion
555
SET XabsolutePrevious = Xabsolute,
SET YabsolutePrevious = Yabsolute,
SET XbuttonPrevious = Xbutton,
SET YbuttonPrevious = Ybutton
560
570
580
590
GO TO STOP
595

FIG. 5.



XCOMPUTE
200
INITIALIZE VARIABLES
SET Xstate = Peak1
205
Xloop Start
210
N = N + 1
Xsum = Xsum + X(N)
215
XweightSum = XweightSum + N * X(N)
220
Xstate=Peak1?
225
YES
NO
X(N) ≥ X(N-1)?
230
YES
NO
Xpeak = X(N-1)
Set Xstate = Valley
232
Xstate = Valley?
250
YES
NO
X(N) ≤ X(N-1)?
250
YES
NO
Xvalley = X(N-1)
Set Xstate = Peak2
262
Xstate=Peak2?
270
YES
NO
X(N) ≥ X(N-1)?
275
NO
YES
Xpeak2 = X(N-1)
Xstate = Tail
278
N = Xcon?
235
NO
YES

FIG. 6-1.



290
Xpeak1>Fthresh
OR
Xpeak2>Fthresh
NO
YES
295
Set Xabsolute =
XweightSum / Xsum
305
(Xpeak1-XValley) >
(Xpeak1)/4? and
(Xpeak2-XValley) > (Xpeak2)/4? and
Xpeak1 > Fthresh? and
Xpeak2 > Fthresh?
NO
YES
315
Xbutton = Up
310
Xbutton = Down
320
END

FIG. 6-2.

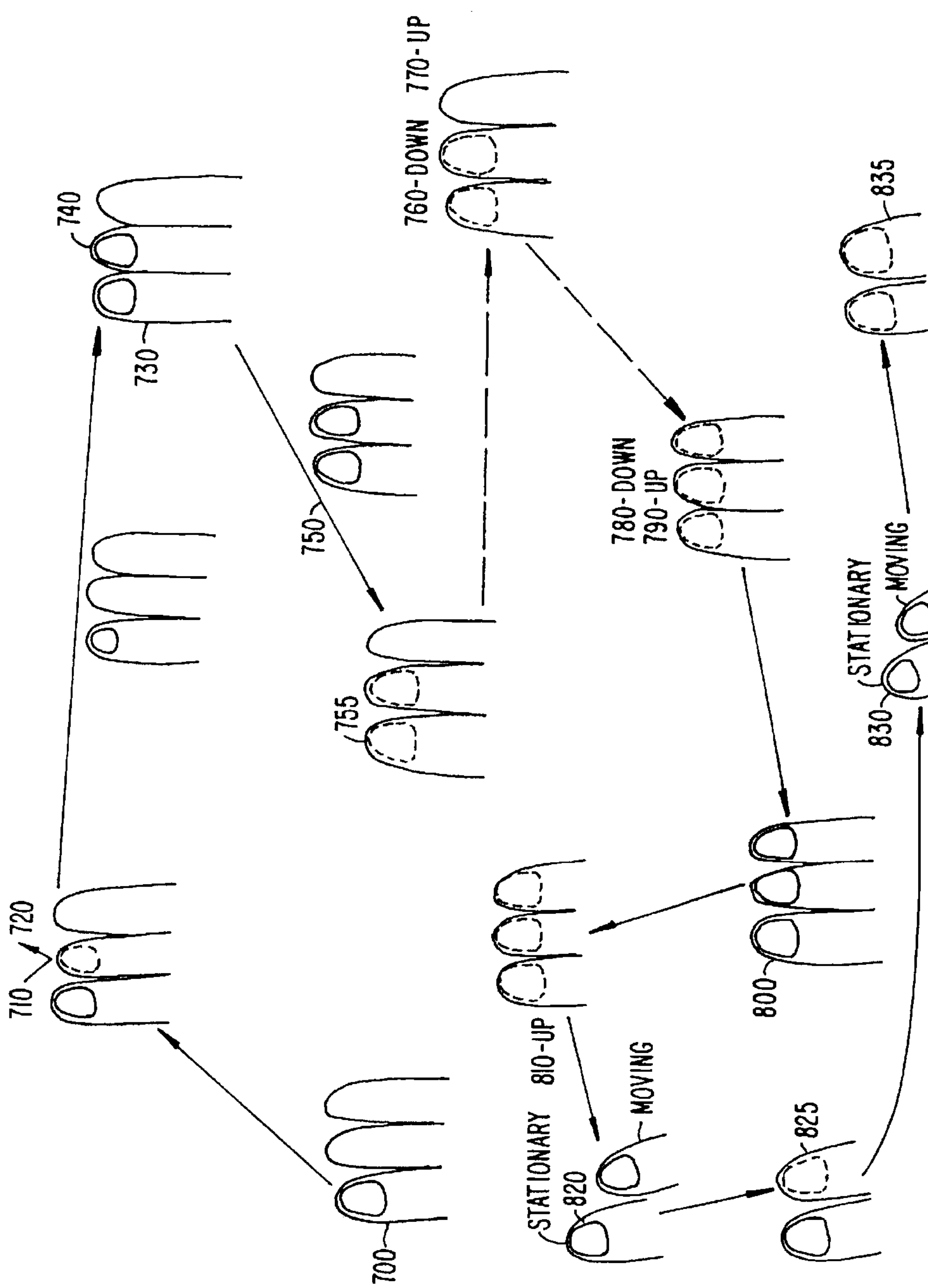

700
710
720
730
740
750
755
760-DOWN
770-UP
780-DOWN
790-UP
800
810-UP
STATIONARY
820
MOVING
825
STATIONARY
830
MOVING
835

FIG. 7A.

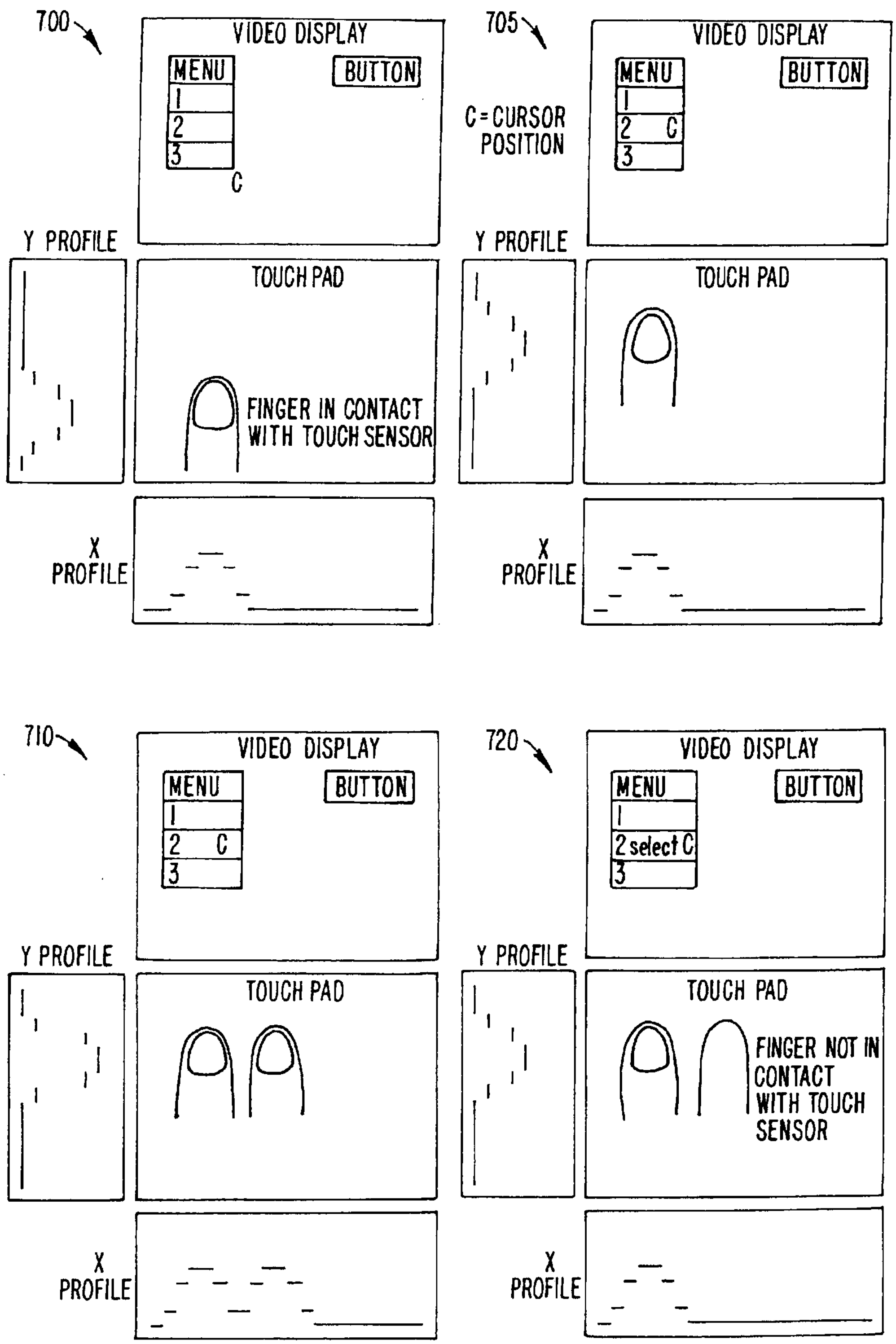

700
VIDEO DISPLAY
MENU
1
2
3
BUTTON
C
Y PROFILE
TOUCH PAD
FINGER IN CONTACT WITH TOUCH SENSOR
X PROFILE
705
C=CURSOR POSITION
VIDEO DISPLAY
MENU
1
2 C
3
BUTTON
Y PROFILE
TOUCH PAD
X PROFILE
710
VIDEO DISPLAY
MENU
1
2 C
3
BUTTON
Y PROFILE
TOUCH PAD
X PROFILE
720
VIDEO DISPLAY
MENU
1
2 select C
3
BUTTON
Y PROFILE
TOUCH PAD
FINGER NOT IN CONTACT WITH TOUCH SENSOR
X PROFILE

FIG. 7B.

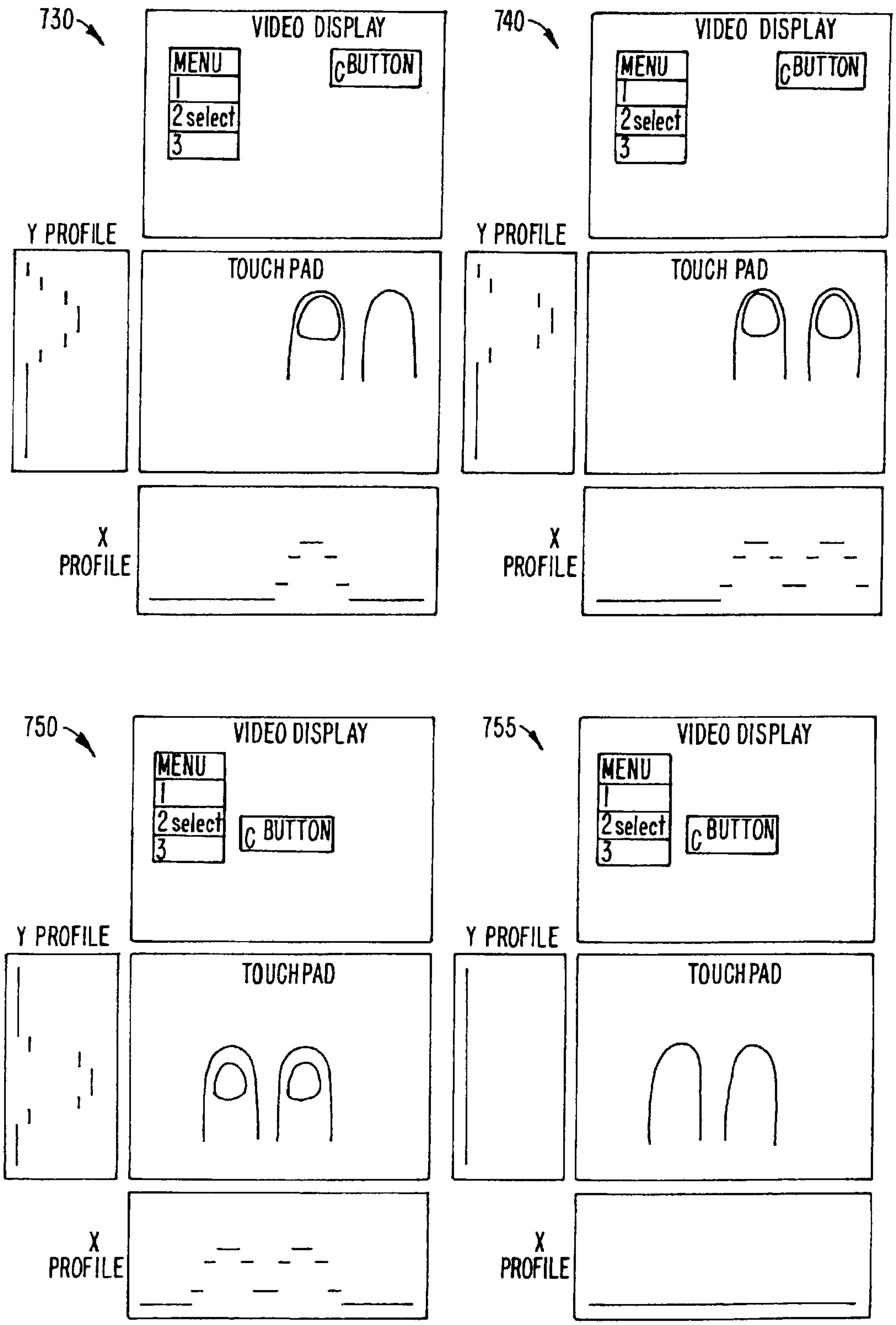

730
VIDEO DISPLAY
MENU
1
2 select
3
BUTTON
Y PROFILE
TOUCH PAD
X PROFILE
740
VIDEO DISPLAY
MENU
1
2 select
3
BUTTON
Y PROFILE
TOUCH PAD
X PROFILE
750
VIDEO DISPLAY
MENU
1
2 select
3
BUTTON
Y PROFILE
TOUCHPAD
X PROFILE
755
VIDEO DISPLAY
MENU
1
2 select
3
BUTTON
Y PROFILE
TOUCHPAD
X PROFILE

FIG. 7C.

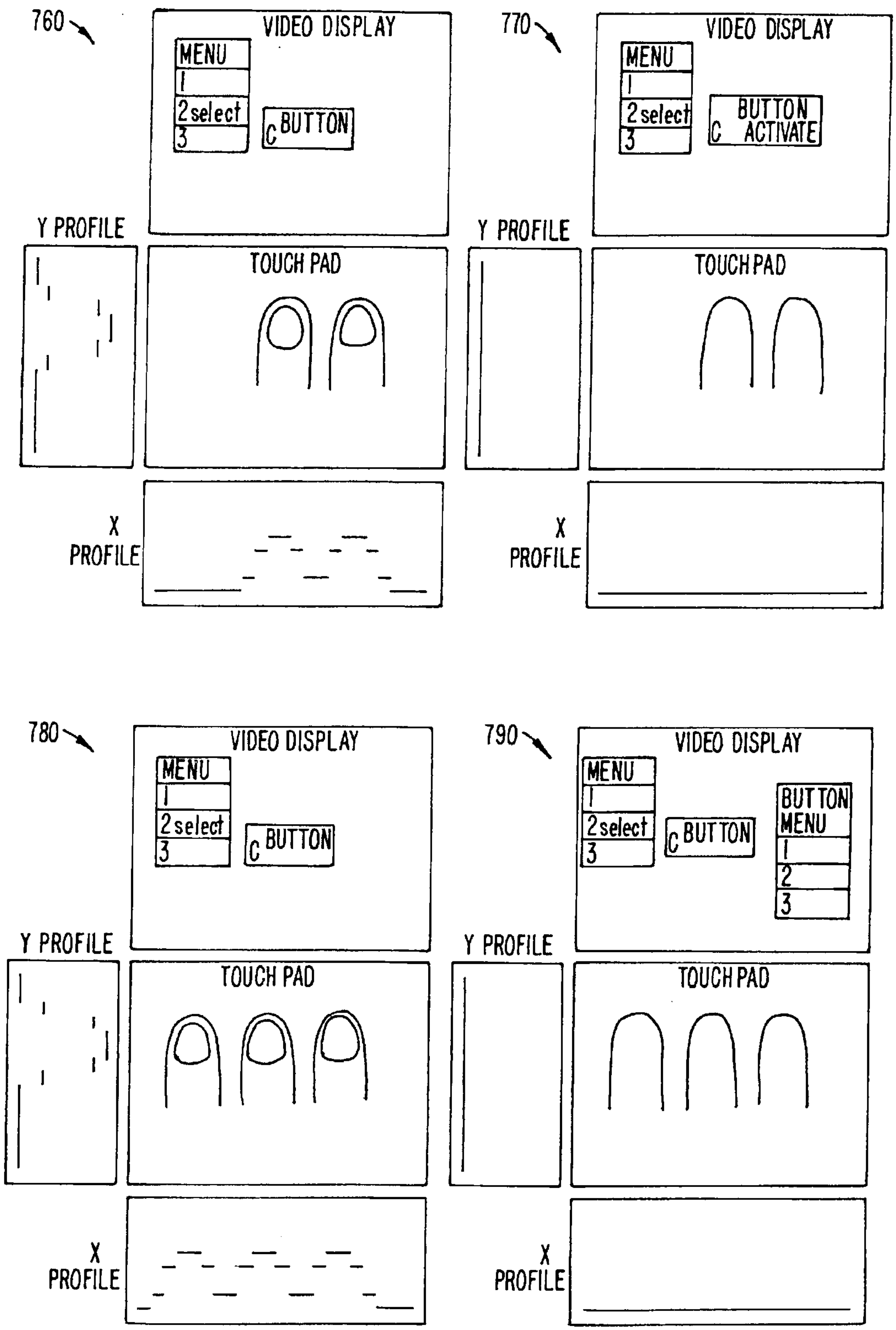

760
VIDEO DISPLAY
MENU
1
2 select
3
C BUTTON
Y PROFILE
TOUCH PAD
X PROFILE
770
VIDEO DISPLAY
MENU
1
2 select
3
C BUTTON ACTIVATE
Y PROFILE
TOUCH PAD
X PROFILE
780
VIDEO DISPLAY
MENU
1
2 select
3
C BUTTON
Y PROFILE
TOUCH PAD
X PROFILE
790
VIDEO DISPLAY
MENU
1
2 select
3
C BUTTON
BUTTON MENU
1
2
3
Y PROFILE
TOUCH PAD
X PROFILE

FIG. 7D.

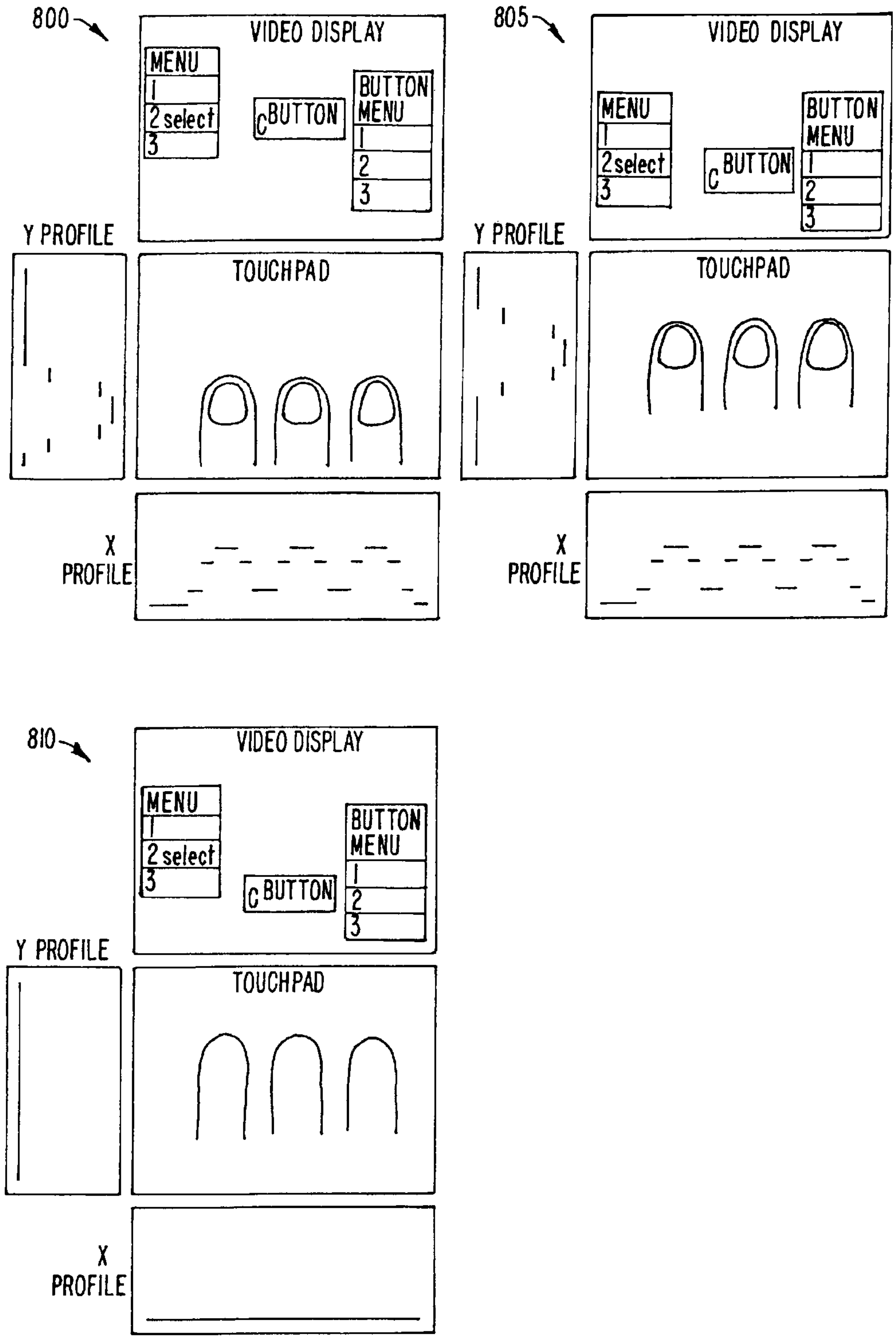
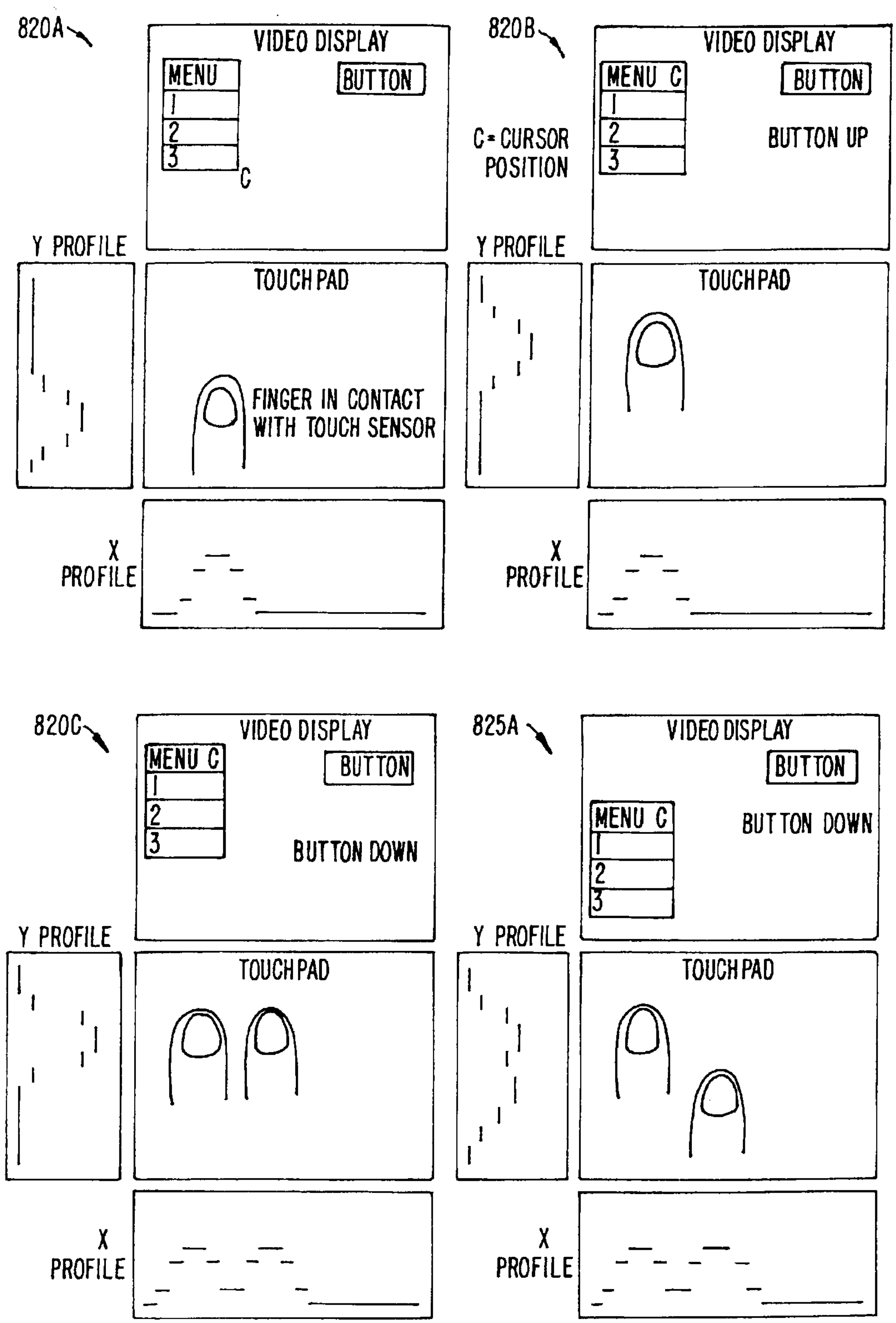
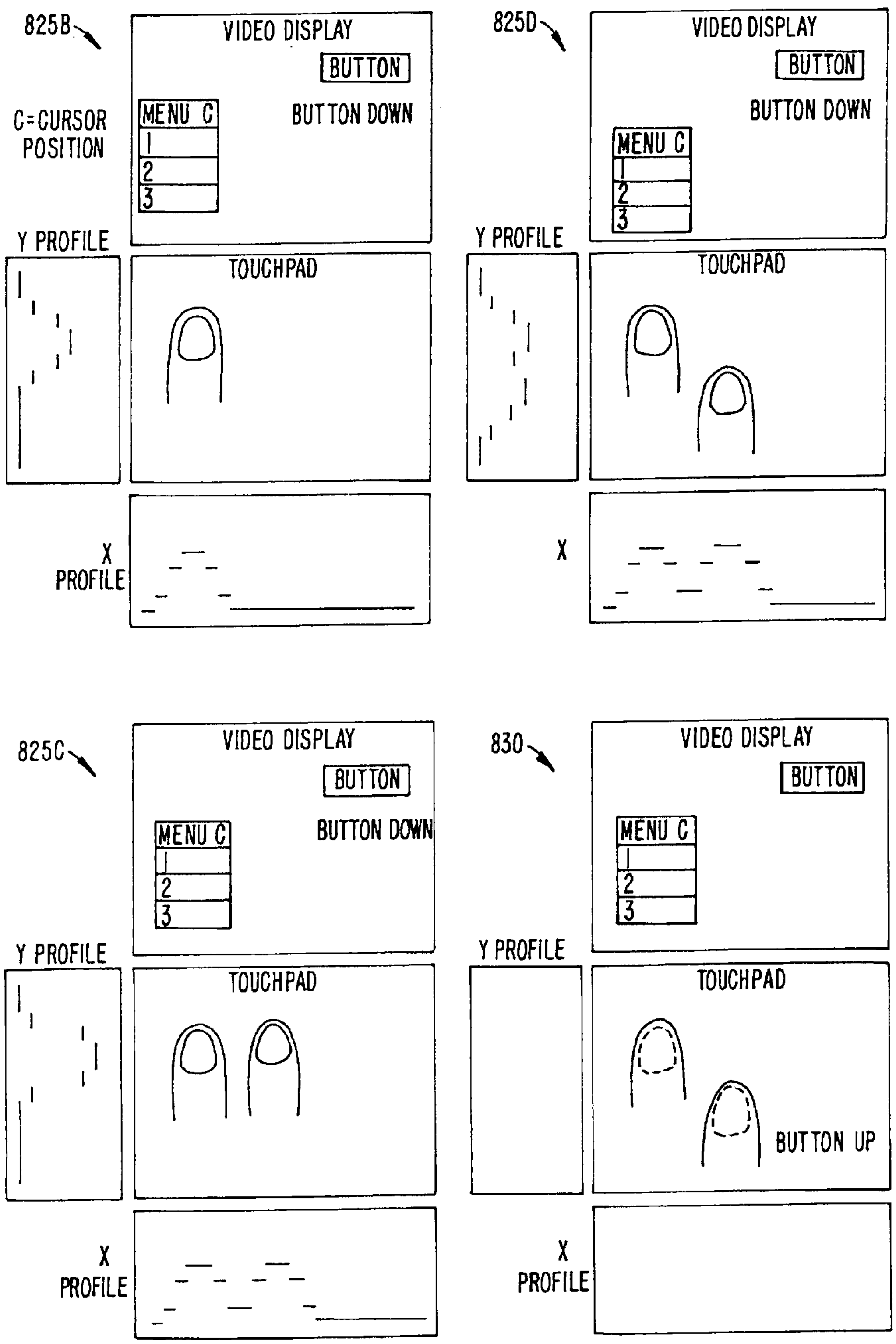

800
VIDEO DISPLAY
MENU
1
2 select
3
C BUTTON
BUTTON MENU
1
2
3
Y PROFILE
TOUCHPAD
X PROFILE
805
VIDEO DISPLAY
MENU
1
2 select
3
C BUTTON
BUTTON MENU
1
2
3
Y PROFILE
TOUCHPAD
X PROFILE
810
VIDEO DISPLAY
MENU
1
2 select
3
C BUTTON
BUTTON MENU
1
2
3
Y PROFILE
TOUCHPAD
X PROFILE

FIG. 7E.



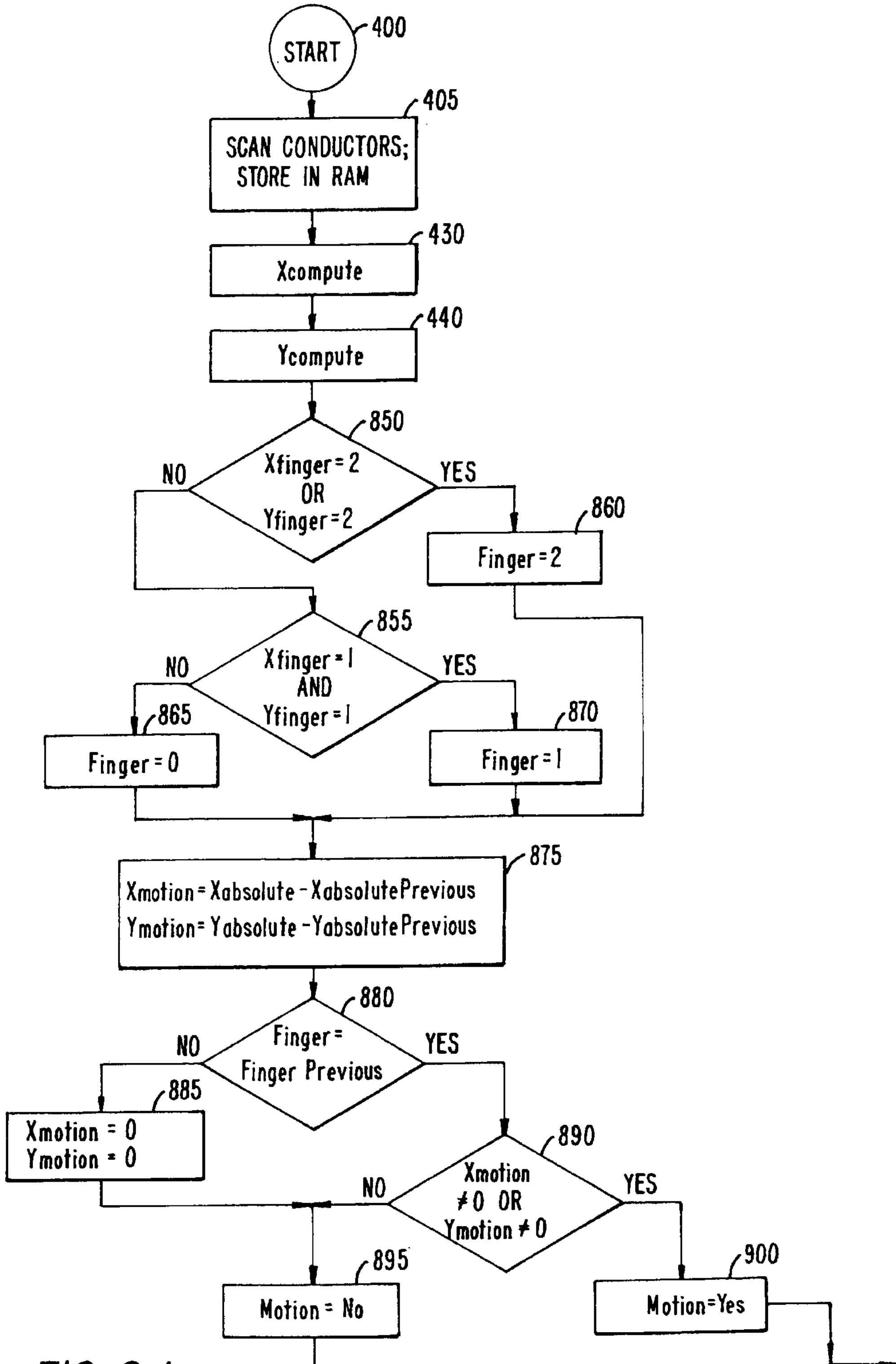
820A
VIDEO DISPLAY
MENU
1
2
3
C
BUTTON
Y PROFILE
TOUCH PAD
FINGER IN CONTACT
WITH TOUCH SENSOR
X
PROFILE
820B
VIDEO DISPLAY
MENU C
1
2
3
BUTTON
BUTTON UP
C=CURSOR
POSITION
Y PROFILE
TOUCH PAD
X
PROFILE
820C
VIDEO DISPLAY
MENU C
1
2
3
BUTTON
BUTTON DOWN
Y PROFILE
TOUCH PAD
X
PROFILE
825A
VIDEO DISPLAY
BUTTON
MENU C
1
2
3
BUTTON DOWN
Y PROFILE
TOUCH PAD
X
PROFILE

FIG. 7F-1.



825B
C=CURSOR POSITION
VIDEO DISPLAY
BUTTON
MENU C
1
2
3
BUTTON DOWN
Y PROFILE
TOUCHPAD
X PROFILE
825D
VIDEO DISPLAY
BUTTON
BUTTON DOWN
MENU C
1
2
3
Y PROFILE
TOUCHPAD
X
825C
VIDEO DISPLAY
BUTTON
MENU C
1
2
3
BUTTON DOWN
Y PROFILE
TOUCHPAD
X PROFILE
830
VIDEO DISPLAY
BUTTON
MENU C
1
2
3
Y PROFILE
TOUCHPAD
BUTTON UP
X PROFILE

FIG. 7F-2.



START
400
SCAN CONDUCTORS; STORE IN RAM
405
Xcompute
430
Ycompute
440
Xfinger = 2 OR Yfinger = 2
850
NO
YES
Finger = 2
860
Xfinger = 1 AND Yfinger = 1
855
NO
YES
Finger = 0
865
Finger = 1
870
Xmotion = Xabsolute - XabsolutePrevious
Ymotion = Yabsolute - YabsolutePrevious
875
Finger = Finger Previous
880
NO
YES
Xmotion = 0
Ymotion = 0
885
Xmotion ≠ 0 OR Ymotion ≠ 0
890
NO
YES
Motion = No
895
Motion = Yes
900

FIG. 8-1.

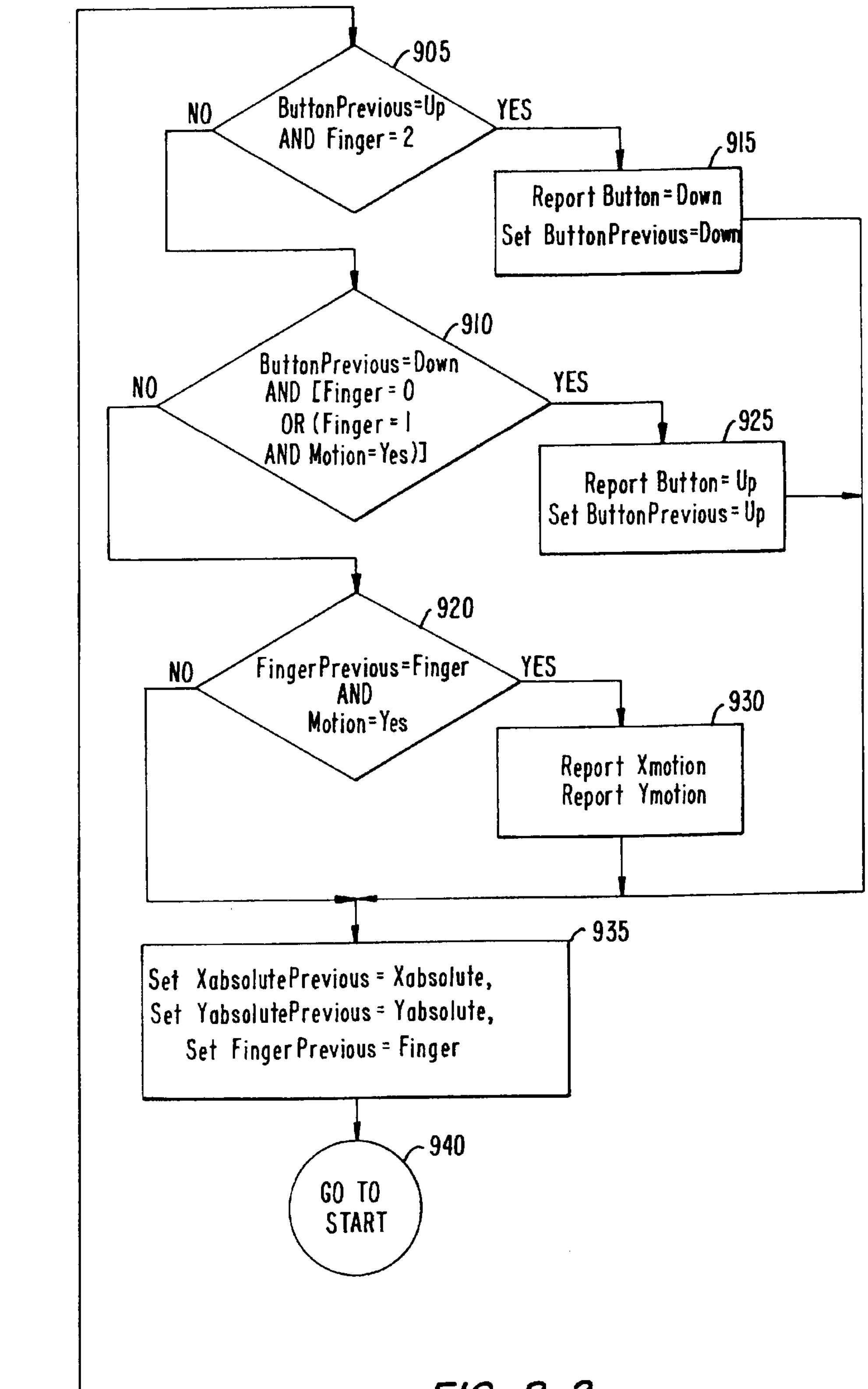
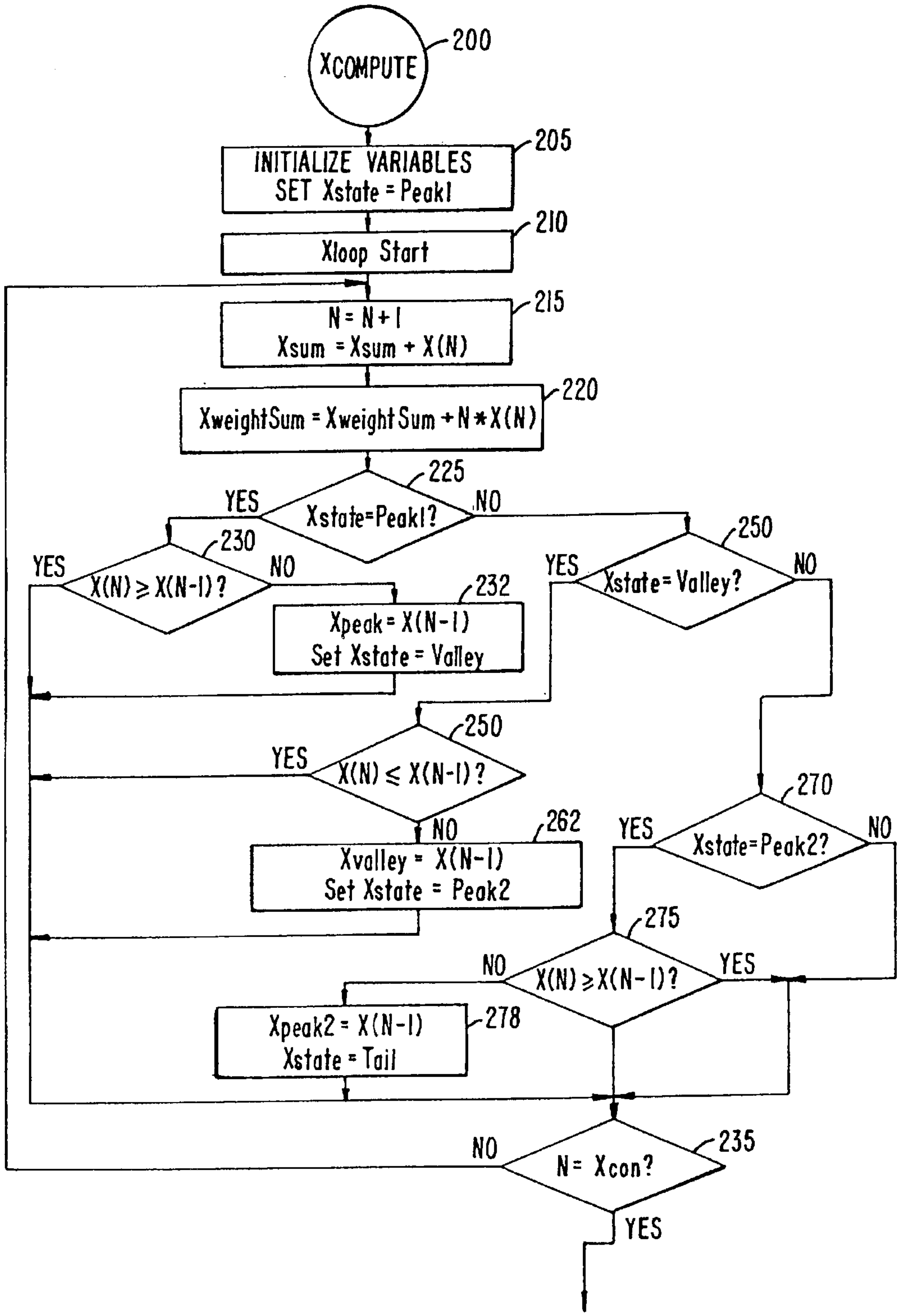

905
ButtonPrevious=Up
AND Finger=2
NO
YES
915
Report Button=Down
Set ButtonPrevious=Down
910
ButtonPrevious=Down
AND [Finger=0
OR (Finger=1
AND Motion=Yes)]
NO
YES
925
Report Button=Up
Set ButtonPrevious=Up
920
FingerPrevious=Finger
AND
Motion=Yes
NO
YES
930
Report Xmotion
Report Ymotion
935
Set XabsolutePrevious=Xabsolute,
Set YabsolutePrevious=Yabsolute,
Set FingerPrevious=Finger
940
GO TO
START

FIG. 8-2.



XCOMPUTE
200
INITIALIZE VARIABLES
SET Xstate = Peak1
205
Xloop Start
210
N = N+1
Xsum = Xsum + X(N)
215
XweightSum = XweightSum + N*X(N)
220
Xstate=Peak1?
225
YES
NO
X(N) ≥ X(N-1)?
230
YES
NO
Xpeak = X(N-1)
Set Xstate = Valley
232
Xstate = Valley?
250
YES
NO
X(N) ≤ X(N-1)?
250
YES
NO
Xvalley = X(N-1)
Set Xstate = Peak2
262
Xstate=Peak2?
270
YES
NO
X(N) ≥ X(N-1)?
275
NO
YES
Xpeak2 = X(N-1)
Xstate = Tail
278
N = Xcon?
235
NO
YES

FIG. 9-1.

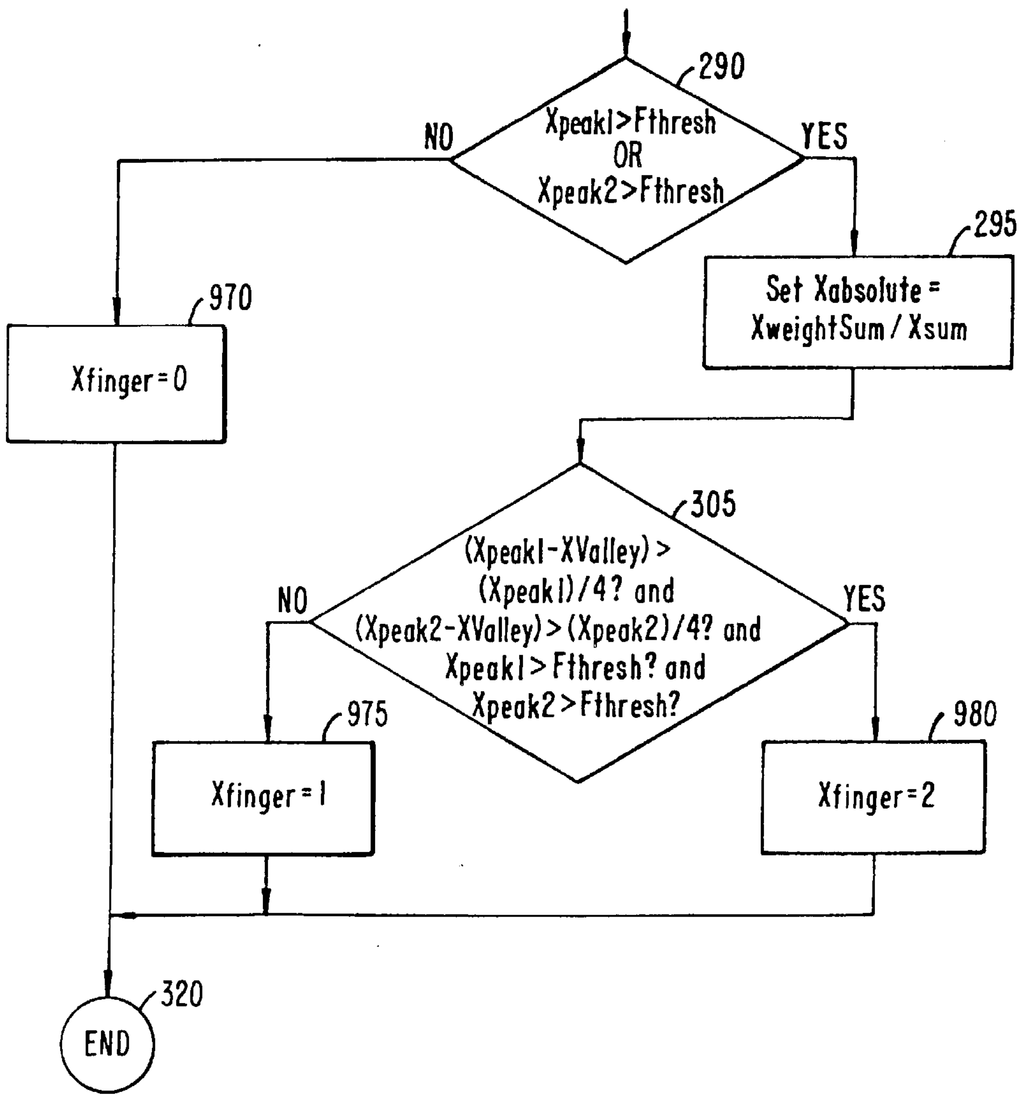

290
Xpeak1>Fthresh
OR
Xpeak2>Fthresh
NO
YES
295
Set Xabsolute =
XweightSum / Xsum
970
Xfinger=0
305
(Xpeak1-XValley) >
(Xpeak1)/4? and
(Xpeak2-XValley)>(Xpeak2)/4? and
Xpeak1>Fthresh? and
Xpeak2>Fthresh?
NO
YES
975
Xfinger=1
980
Xfinger=2
320
END

FIG. 9-2.

MULTIPLE FINGERS CONTACT SENSING METHOD FOR EMULATING MOUSE BUTTONS AND MOUSE OPERATIONS ON A TOUCH SENSOR PAD

RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 08/582,768, filed Jan. 4, 1996, abandoned.

FIELD OF THE INVENTION

The present invention relates generally to touchpad devices, and more particularly relates to touchpad devices which detect at least the presence of one or more objects such as fingers to effectuate preselected control functions.

BACKGROUND OF THE INVENTION

Touch sensing devices are well known, and take a number of different forms. Perhaps the best known are resistive-membrane position sensors, which have been used in a number of different applications for many years. Such devices have been used as keyboards, position indicators, and so forth. Other types of touch sensing devices include resistive tablets, surface acoustic wave devices, touch sensors based on strain gages or pressure sensors, and optical sensors.

Yet another touch sensing technology is capacitive sensing, in which the location of a finger (or in some instances another object such as a stylus) over a sensing device is determined by virtue of variations in capacitance under and around the location of the finger. Typical of capacitive touch sensing devices are touch screens and capacitive pads which employ a matrix of row and column electrodes and detect, for example, either the transcapacitance between row and column electrodes or the effective capacitance to virtual ground. Other capacitive techniques are also known. Some touch sensitive devices are known to use interpolation for more precisely identifying the location of a finger or stylus.

Typical of each of these prior art devices is that each of them senses any contact as that of only one finger at a time. Cursor movement is straightforward with one finger, and tapping of a finger on the surface of the pad can be detected and acted upon in a manner similar to detecting the actuation of a button on a mouse. Single and double taps can be used as simple equivalents of single and double mouse clicks.

With a single-finger touchpad, the click and drag function is more difficult. With single finger detection, dragging has been implemented with schemes such as uptap (finger lifted and placed down again quickly), tap-and-a-half, and sticky drag (drag lock turns on automatically after the finger is placed in one location without moving for more than a certain time, such as one second). All of these methods take more time and/or more finger motions than it takes to perform the equivalent function with a mouse, and are not intuitive to users familiar with electronic mice. Prior art touch pads are thus less attractive for general use than a mouse.

Another commonly used function in the prior art is that of clicking a box (or icon or displayed "button") or series of boxes (such as "connecting the dots"). With a mouse, the cursor is moved into position by moving the mouse, then the click occurs with a down-up motion of the finger to actuate a button or switch. With a touchpad typical of the prior art, the cursor is moved into position with the finger, then the click occurs with a tap of the finger which moved the cursor.

This requires an up-down-up-down finger motion to do the same thing as simply the "down-up" motion of the mouse button. In general, any touchpad equivalent to a mouse button-clicking function requires an extra "up . . . up" motion of the finger, because the finger must be lifted off the pad before and after the tap.

The time and stress associated with the extra motion is significant. Human factors studies have shown that such touchpads yield lower productivity than a mouse in many applications. This somewhat limits touchpads to those applications, such as portable computing, where use of a mouse is inconvenient due to space or other considerations. There is therefore a need for a touchpad capable of yielding the same productivity as a mouse.

SUMMARY OF THE INVENTION

The present invention provides a novel method and apparatus for sensing the proximity of multiple simultaneous fingers or other appropriate objects to a touch sensor. The present invention may be implemented based on any conventional touch sensing technology, although an exemplary embodiment involves the use of a capacitive touch sensing device similar to that described in U.S. patent application Ser. No. 08,478,290, entitled Touch Sensing Method and Apparatus, filed Jun. 7, 1995, and assigned to the assignee of the present application. The numerous modifications to such a basic device required to implement the present invention are described generally below, and in detail hereinafter. Alternatively, the present invention may be used with the method and apparatus described in the U.S. patent application Ser. No. 08/582,769, entitled Touch Pad Sensing Method and Apparatus, having as inventors Bemi Joss, Bernard Kasser and Stephen Bisset, filed on Jan. 4, 1996, and assigned to the assignee of the present invention, the relevant portions of which are incorporated herein by reference.

Operation of the present invention includes two aspects: detection of multiple objects, typically fingers, and assignment of various functions to particular actions by the movement of one or both fingers. The detection function can be general, but in a simple, exemplary implementation can be limited to a two-finger function such as the combination of the index finger and middle finger. In general, these are the two most dextrous fingers, and they work well together. As a result, for this exemplary embodiment, the touchpad need only distinguish between the two fingers in one dimension since the two fingers are typically side by side. In addition, the touchpad need only detect the second finger in reasonably close proximity to the first finger. In most situations, the distance between finger centers will be less than five centimeters. Additional combinations of fingers, such as three fingers tapping simultaneously or other combinations, may also be implemented in accordance with the methodology of the present invention.

For clarity of explanation, the present invention can be described in most of its applications by establishing one finger as controlling movement of the cursor, and the second finger as controlling functions equivalent to a mouse button or switch. In this context, one finger may be considered the "point" finger, while the other is the "click" finger. Various conventional functions may then be defined accordingly. For example, "drag" may be effected by moving the two fingers in unison, "point and click" may be effected by moving the cursor with the first finger and tapping with the second finger, "point and double click" may be effected by moving the cursor with the first finger and double tapping with the

second finger, and so on. "Click and Drag" may be performed simply by moving the cursor to the appropriate position with the first finger, placing both first and second fingers on the pad, and moving both fingers together. The function may be concluded by simply raising one or both fingers. Similarly, connecting the dots may be performed simply by moving the cursor from dot to dot with the first finger, and then clicking on the dot by tapping with the second finger. It will be apparent to those skilled in the art that these functions may be defined differently and still fall within the scope of the present invention. It will also be apparent that many of these operations will be intuitive to experienced mouse users, as soon as the correspondence between mouse functions and the two fingers is demonstated to the user, and thus their implementation in a touchpad context makes them especially desirable.

In addition to the foregoing functions, which can be performed (albeit awkwardly and less intuitively) with conventional touch pads, there are additional functions that can be performed with two fingers and which can have substantial analogs to the use of a mouse or even go beyond conventional mouse functions. For example, detection and location of two fingers will permit the touchpad to report to a host system the distance between the two fingers. This can be used, for example, in paint or other programs to determine line width or other spacing functions, or any other "variable value" function. Similarly, tapping with both fingers at the same time may be defined as an alternate, shorthand method for a double tap (such as may be defined for the middle button in a Logitech mouse) or may be defined as a special function, similar to the "right button" functions of a mouse. Such special functions may have particular value in operating systems such as Windows 95 where, for example, implementation of the Object Viewer function is an important special function. Such functions can be implemented readily with a triple finger tap, a double tap of two fingers, or other convenient combination.

Another function which may be implemented with two finger detection is "drag lock". This function may be used when a drag function is underway, but at least one of the fingers reaches the edge of the pad before the drag function is complete. Touchpad operation may be controlled to maintain the drag mode if, for example, both fingers are lifted off the pad within a threshold period of one another, and are then placed down on the pad again within a suitable time period. In some implementations, highly extended time periods may be suitable in this context.

A further function which may be readily implemented with the present invention is the ability to operate in relative mode, where a first finger performs a key function, and a second finger controls some attribute of the operation performed by the first finger. For example, a first finger contacting a touch pad may cause a cursor to move across a screen, while contact (and removal) of a second finger with the screen may turn an image, or "ink" on (and off). The resulting image, or "ink," is defined by the motion of the first finger during the period when the second finger is also in contact with the pad; gaps in the "ink" occur when the second finger is lifted away from the pad. The function may, in some ways, be thought of as electronic finger painting, but has the additional advantage of allowing multiple characters to be written on a touch pad. Thus, with the use of two fingers, hand printing of text with gaps between the letters and words becomes feasible and convenient, whereas it is impractical with the prior art "tap and a half" method of turning on the ink.

Yet another function which may be implemented with the present invention is use of the touchpad in absolute mode. Most prior art touchpad devices operate, like mice, in relative mode by indicating the distance travelled relative to the starting point of the motion. Touchpads, on the other hand, can also be operated in absolute mode, where the absolute position of the finger on the pad is detected and reported to the host system or application. In absolute mode, multi-finger detection allows the first finger to point to the desired absolute position, while the second finger performs whatever "click" operation is desired without requiring a removal of the first finger which might lessen accuracy or resolution.

Also included within the present invention is the detection and location of more than two fingers, with accompanying functional definitions permitting such multiple contacts to indicate pointing device or other control operations, such as musical keyboards.

It is therefore one object of the present invention to provide a touchpad system capable of detecting a plurality of contacts such as fingers.

It is a further object of the present invention to provide a touchpad device capable of locating a plurality of contacts such as fingers.

It is a further object of the present invention to provide a method for detecting the presence of more than one finger on a touch pad device.

It is a still further object of the present invention to provide a method for locating each of a plurality of fingers on a touch pad device.

It is yet another object of the present invention to provide a method for effecting the "point and click" function on a touchpad through the use of multiple fingers.

Yet a further object of the present invention is to provide a method for effecting the "click and drag" function on a touchpad through the use of multiple fingers.

A still further object of the present invention is to provide a method for effecting on a touchpad, through the use of multiple finger contacts, a plurality of conventional mouse button functions.

Yet another object of the present invention is to provide a method and apparatus for effecting on a touchpad, through the use of multiple finger contacts, a plurality of enhanced functions.

Yet a further object of the present invention is to provide a method and apparatus for electronic finger painting.

These and other objects of the invention may be better appreciated from the following detailed description of the invention, taken together with the appended figures.

THE FIGURES

FIG. 1 shows a perspective view of a device according to the present invention.

FIG. 2 shows in block diagram form the electronics of the present invention.

FIG. 3 shows a finger profile for two non-overlapping fingers as sensed by the present invention.

FIG. 4 shows a finger profile for two closely-spaced fingers as sensed by the present invention.

FIG. 5 shows in flow diagram form the steps for a high level algorithm for a pointing device according to the present invention.

FIG. 6 shows in flow diagram form the steps for computing motion and "button" states.

FIGS. 7A–7F2 show in diagrammatic form an exemplary sequence of finger contacts and movements across a touch sensor.

FIG. 8 shows a more generalized case of FIG. 5.

FIG. 9 shows a more generalized case of FIG. 6.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to FIG. 1, a plurality of a user's fingers 10A and 10B are shown positioned over a touchpad 20 in sufficiently close proximity to be operatively connected thereto. Movement of a single finger over the touchpad causes the cursor to move in a now-conventional manner. However, unlike prior art devices, various control functions may be performed by the use of the second finger, typically in combination with the same or a related operation of the first finger. Operations involving more than two fingers may also be performed. In an exemplary embodiment, the touchpad of the present invention reports to a host either the relative motion of a finger across the touchpad or changes in "button" status.

Referring next to FIG. 2, the operation of the touchpad 20 may be better appreciated. In particular, FIG. 2 shows in block diagram form the electronics implemented to form an exemplary touchpad 20. A touchpad matrix 30 is composed of a plurality of rows 35 and columns 40 of wires or traces arranged in a conventional manner; see U.S. patent application Ser. No. 08/321,987, filed 12 Oct. 1994, entitled Touch Pad Sensor with Simultaneous Sensing, commonly assigned with the present application. The rows and columns are connected to an analog multiplexor 45 through a plurality of X (row) direction conductors 50 and a plurality of Y (column) direction conductors 55, one conductor for each row and each column. Under the control of a microcontroller 60, the analog multiplexor 45 selects which traces of the matrix 30 will be sampled, and the output of those traces is then provided to a capacitance measuring circuit 70. One suitable capacitance measuring circuit is described in aforementioned U.S. patent application Ser. No. 08/321,987, commonly assigned with the present invention and incorporated herein by reference; another is described in U.S. patent application Ser. No. 08/478,290, filed 7 Jun. 1995, entitled Touch Sensing Method and Apparatus and also commonly assigned with the present invention and incorporated herein by reference.

The output of the capacitance measuring circuit is then provided to an analog to digital converter 80, which operates as described in either of the above-referenced patent applications to convert the capacitance values from the circuit 70 into a digital representation. The analog to digital converter 80 then supplies the signals to the microcontroller 60, which operates to form, among other things, a finger profile for one or more fingers, X-Y cursor data, and control signals. Depending on the operation being performed at the particular time, the output of microcontroller 60 is then supplied to an interface to a PC or other device, such as a PS/2 interface, an RS-232 interface, or an Apple Desktop Bus (ADB).

A key feature of the present invention is its ability to distinguish the presence of multiple fingers either touching or in operative proximity to the touchpad 30. In a typical embodiment, the operation of the circuit of FIG. 2 cycles continuously. As noted above, the cycle begins by scanning the traces and measuring the capacitance on each trace. Then the portion of each measured capacitance that is induced by the presence of a finger is extracted, and this finger-induced capacitance is stored in RAM, as X(1) through X(Xcon) and Y(1) through Y(Ycon), as described below. The finger-induced portion of the measured capacitance is determined by subtracting a value, for each trace, representing the capacitance when no finger is present. This "no-finger" capacitance is measured and stored at a time previous to the beginning of the cycle described herein, and is described more fully in U.S. patent application Ser. No. 08/478,290, filed 7 Jun. 1995 and commonly assigned.

It has also been found by applicant that it is not necessary, in all embodiments, to subtract the "no-finger" capacitance if techniques other than calculation of a centroid are used to locate the position of the fingers, and such subtraction is not required even in all instances in which a centroid is calculated. However, in at least some embodiments the sensitivity and hence the resolution of the calculated finger location is enhanced by such subtraction.

Referring again to the exemplary embodiment, the values of finger-induced capacitance are then processed to calculate a position, detect whether one or more fingers is in operative contact with the pad surface, and to detect any changes in the number of fingers operatively coupled to the pad. If the cycle is repeated rapidly enough to update a graphical user interface approximately 30 times per second or more, the appearance of smooth and instantaneous response is provided to the user. For functions other than pointing, such as handwriting with the finger, a faster scan rate may be required and may, for example, be on the order of 200 scans per second.

Referring next to FIG. 3, a finger profile is shown indicative of the presence of two fingers, spaced apart from one another. In particular, the circuitry, software or firmware of the touchpad circuitry, such as that shown in FIG. 2, detects a first maxima 85 indicative of a first finger in operative proximity to the touchpad 30, followed by a minima 90 indicative of a space between the fingers, and further followed by another maxima 95 indicative of a second finger operatively coupled to the touchpad 30. It will be appreciated that, for operations involving more than two fingers, more maxima will be detected with an appropriate number of intermediate minima.

Although the finger profile shown in FIG. 3 suggests that the intermediate minima separating the two fingers is a zero value, it is not necessary in all instances that the minima be zero. Thus, for example, FIG. 4 reflects a finger profile with a nonzero local minima 100 intermediate the two maxima 105 and 110 indicative of two fingers operatively coupled to the touchpad. This finger profile simply reflects two fingers placed closely to one another, but still yields a valley for measurement of the minima.

To operate effectively, the present invention must detect and distinguish the presence of a single finger, and the presence of multiple fingers. As noted previously, the second or additional fingers are typically involved to provide "button" or control functions, similar to actuation of the buttons or switches on a mouse. Although the following example describes in detail the use of only two fingers, one for cursor control and a second as a button, the teachings herein are believed sufficient to permit those skilled in the art to construct apparata using multiple fingers for additional buttons.

To avoid artifacts, a threshold may be applied to the both the maximum and minimum distance between the maxima representative of multiple fingers. For example, a threshold requiring the maxima to be within five centimeters of one another may be used to limit the maximum distance between the fingers; other thresholds may be appropriate in some embodiments. A threshold representative of the minimum distance may be configured by establishing a maximum value of the local minima 100.

In an exemplary embodiment, the operation of the system of FIG. **2** is controlled in either firmware, software or hardware. Shown in FIG. **5** is a flow diagram showing the general operation of such software or firmware which is capable of detecting multiple fingers, and which uses the algorithm of FIG. **6**, discussed hereinafter. The variables found in the flow diagram of FIG. **5** are defined below:

Name	Definition
Xabsolute	Finger position in X direction, calculated during the current cycle relative to the sensor pad.
XabsolutePrevious	The value above stored from the previous cycle.
Yabsolute	Similar to Xabsolute.
YabsolutePrevious	Similar to XabsolutePrevious.
Xbutton	Has value Up or Down (regardless of previous state).
XbuttonPrevious	The value above stored from the previous cycle.
Ybutton	Similar to Xbutton.
YbuttonPrevious	Similar to XbuttonPrevious.
Xmotion	Cursor motion in the X direction, relative to the cursor position of the previous cycle (only reported if either or both Xmotion and Ymotion are non-zero).
Ymotion	Similar to Xmotion.
Button	May be Up or Down (only reported if a change from the previous cycle).

It will be understood by those skilled in the art that a "report" means transmitting information to an application process executing on a host, such that the cursor is moved or a function is performed. In some instances, driver software executing on the host may ascertain the existence of finger movement, while in other instances including the exemplary embodiment described herein the determination of finger movement occurs in the firmware in the pointing device.

Referring still to FIG. **5**, the cyclical process begins at step **400**, and continues at step **410** by scanning the conductor sensors. The sensors may be scanned sequentially or concurrently, depending on the hardware implementation. The scan process measures the values of finger-induced capacitance for each of the conductors, and stores the values in RAM at step **420**. The cycle process continues by performing the Xcompute loop of FIG. **6** discussed hereinafter, and also the Ycompute loop analogous to FIG. **6**, at step **430** and **440**, respectively. In general, the function of the Xcompute and Ycompute processes is simply to evaluate the current measurements by calculating the centroid of the finger measurement, and by detecting whether a second finger is touching the pad—which determines the button state.

In the exemplary embodiment, only a change in the button state is reported. As a result, at step **450** the value of Button is set to No Change. In addition, in the exemplary embodiment a tap or double click by only a first finger is not acted upon, although a tap by a second finger or by multiple fingers is acted upon. In the exemplary arrangement, a "button down" condition is only reported if both fingers are in operative contact with the touchpad.

The process continues by comparing the current and previous button states of the X and Y conductors. First, at step **460**, the state of Xbutton is checked to see if it is Down and the state of XbuttonPrevious is checked to see if it is Up. If both compares are true, then the variable Button is set to Down at step **465**. In addition, at step **470**, the state of Ybutton is checked to see if it is Down and the state of YbuttonPrevious is checked to see if it is Up. If both compares are true, the variable Button is also set to Down.

Alternatively, as determined at step **480**, if the state of Xbutton is Up and the state of XbuttonPrevious is Down, or, as checked at step **490**, the state of Ybutton is up and YbuttonPrevious is Down, then the variable Button is set to Up at step **495**.

If the button was set to Down at state **465**, or Up at step **495**, or if the results at steps **480** and **490** are NO, the process advances to step **510**.

At step **510**, Xmotion is set to the sum of Xabsolute less XabsolutePrevious, and at step **520**, Ymotion is set to the sum of Yabsolute less YabsolutePrevious. Then, at step **530**, the state of Button is checked and, if it is changed by being either Up or Down, both Xmotion and Ymotion are set to zero at step **535**, indicating that the user has actuated a button and no cursor movement should occur.

In addition, if Button equals Up or Down, the state of Button is reported at step **540**. At step **550**, Xmotion and Ymotion are compared to zero, and if either is not zero then both Xmotion and Ymotion are reported to the microcontroller. It will be apparent that this indicates a cursor movement, typically reflective of the movement of a single finger over the touchpad, or two fingers in some modes such as Click-and-Drag.

Further, at step **560**, whether there is motion reported or not, the variable XabsolutePrevious is set to the value of Xabsolute, and at step **570** the variable YabsolutePrevious is set to the value of Yabsolute. Similarly, at step **580** the value of XbuttonPrevious is set to Xbutton, and at step **590** the value of YabsolutePrevious is set to Yabsolute. The cycle then repeats by returning to step **400**. It will be apparent that the foregoing algorithm can be readily extended to include additional fingers beyond two, representative of additional buttons. In such an instance, compare steps for current and previous states of each button would be conducted, and "up," or "down" conditions would be reported for each such button. In some embodiments it may be desired to report "no change" conditions, and the foregoing algorithm could be readily modified to provide such reporting.

Depending on the desired configuration, second and third buttons may be implemented, for example, either by requiring a combination of two or more fingers to indicate operation of a second button, or by the independent movement of additional fingers or other objects. In this latter embodiment, it may be desirable to implement distance thresholding, to ensure that movement of a second or additional button finger is not mistaken for movement of the first or other button finger.

Set forth in FIG. **6** is a flow diagram setting forth the steps for computing motion and "button" states in the X direction, or what may be referred to as "Xcompute." An analogous calculation is performed for the Y direction, or what may be referred to as "Ycompute." The algorithm uses the following variables and constants:

Name	Definition
X(N)	Values, stored in memory, of finger-induced portion of capacitance measured on each conductor. N varies from 1 to Xcon. [When no finger is contacting the pad above a conductor, the value is approximately zero. In addition, X(0) is initialized to a value of 0.]
X(N-1)	Value of finger-induced sensor conductor capacitance for the previous conductor.
Xcon	The number of sensor conductors in the X direction.
Fthresh	The minimum threshold that X must reach before a finger is considered to be present. [Sets the touch sensitivity of the pad.]
Xpeak1	Variable to store the value of the first peak X value.
Xvalley	Variable to store the value of a local minimum (if any) between 2 peaks.

-continued

Name	Definition
Xpeak2	Variable to store the value of the second peak X value (if any).
Xsum	Variable to accumulate the sum of the X values, for centroid calculation.
XweightSum	Variable to accumulate the sum of the X values, weighted by N (the position of the conductor), for centroid calculation.
Xstate	A variable which can have values Peak1, Valley, Peak2 or Tail, to indicate which part of the finger profile we are currently searching for. The Tail state is simply the remainder of the scan after a second peak (in the exemplary embodiment) has been identified.

It will be apparent to those skilled in the art that the "Ycompute" variables and constants differ only in replacing X by Y.

The algorithm for Xcompute starts at step **200**, followed by initialization of variables at step **205**. For Xcompute, the variables initialized are N, which is set to zero, and the value of X(0), which is also set to zero. In addition, Xpeak**1**, Xvalley, Xpeak**2**, Xsum and XweightSum, are all set to zero. In addition, the state of Xstate is set to Peak**1**.

At step **210** a loop, referred to as "Xloop" starts. The purpose of Xloop is to calculate the X centroid, by accumulating the sum and weighted sum of the X values for all the X conductors from one to Xcon. Thus, the loop typically starts with the value of N=0 and increments by one at the beginning of each cycle until the value of N=Xcon. The steps of the loop include step **215**, where N is incremented to N+1 and the value X(N) of the current conductor is added to the prior accumulated value, Xsum, which then becomes the new value of Xsum. The loop then continues at step **220**, where the prior value of XweightSum is added to a weighted value of X(N), where the weighting is done by multiplying X(N) by the number N of the conductor being sampled. The sum of XweightSum and N*X(N) then becomes the new value of XweightSum.

The XLoop continues at step **225**, where one of a series of subloops is selected depending on the value of Xstate. Since Xstate is initially set to Peak**1**, the first subloop entered is the Peak**1** subloop, beginning at step **230**. At step **230** the value of X(N) is compared to the value of X(N−1) and, if X(N) is greater than or equal to the value of X(N−1), the first peak has not yet been reached. As a result, the loop jumps to step **235**, at which points the value of N is compared to the value of Xcon. If the finger-induced capacitance measured at the last conductor has not been evaluated, the result is a NO and the process jumps to step **215** to repeat with an incremented value of N.

At some value of N the value of X(N) is less than the value of X(N−1), at which point the check at step **230** yields a NO. At this point, the peak has been found and at step **232** the value of Xpeak**1** is set to X(N−1) and the value of Xstate is set to Valley. The system then jumps to step **235**, where a check is made to see if the last conductor has been measured by comparing N to Xcon. As before, if the capacitance change measured at the last conductor has not been checked, the result is a NO, and the process loops to step **215** and repeats.

When the process begins with the next increment of N, a NO will result at step **225**, so that the process will jump to step **250**, where a check is made to see if Xstate equal Xvalley. Since it now does, a YES results and the process branches to step **255**. At step **255** a X(N) is compared to X(N−1). If X(N−1) is not greater than or equal to X(N), the valley has not yet been found, causing a further jump to step **235** and a repeat with an incrementally higher N. If a second finger is touching the pad then eventually the value of X(N−1) will be geater than or equal to the value of X(N), such that the valley is detected. At this point, at step **262**, the value of Xvalley is set to X(N−1) and Xstate is set to Peak2. The process then jumps to step **235**, where it repeats from step **215** unless the last conductor in the matrix has been evaluated.

On the next cycle, a NO result is reached at both step **225** and step **250**, causing a jump to step **270**. At step **270** the state of Xstate is compared to Peak2, and a YES result will occur. This results in a compare between X(N) and X(N−1) at step **275**, to look for a second peak, in a manner substantially identical to the process by which the first peak was found. As long as X(N) is greater than or equal to X(N−1), the peak has not been found, so the process jumps to step **235**, and then to step **215** until the change measured at the last conductor has been evaluated.

As before, the value of X(N) will eventually start to decrease, such that X(N) will be less than X(N−1). At this point, at step **278**, the value of Xpeak**2** is set to the value of X(N−1) and the state of Xstate is set to Tail. The "tail" is the remaining portion of FIG. **4** following the second peak. While a Tail state is used in the exemplary embodiment, such a state may not be necessary in all embodiments.

The process then cycles through until the last conductor measurement has been considered, at which point N does equal Xcon when the check at step **235** is made. With a YES result, the process branches to a thresholding comparison at step **290**.

In an exemplary embodiment, the Xcompute process then continues by calculating the centroid for the fingers detected, so long as the maxima exceed a threshold value. In accordance with the present invention, two approaches may be used in calculating centroid values. In a first implementation, only a single centroid value is calculated for the combination of one or more fingers. In this arrangement, it will be apparent that, when a second finger contacts the touchpad, the centroid "jumps" laterally approximately to the midpoint of the two fingers. In a second implementation, a centroid value may be calculated for each maxima, yielding multiple centroid values when multiple fingers interact with the pad. For purposes of clarity, the following description will be limited to the first implementation.

Thus, at step **290** the values of Xpeak**1** and Xpeak**2** are compared to Fthresh, and if either or both are greater then Xabsolute is set to the value of XweightSum/Xsum at step **295**, which causes the X centroid to be calculated. If neither peak exceeds Fthresh, then no finger is deemed present and Xbutton is set to Up at step **315**.

If both Xpeak**1** and Xpeak**2** were greater than Fthresh, the Xcompute process continues at step **305** by comparing the difference between Xpeak**1** and Valley to the value of Xpeak**1** divided, for example, by four. If the difference is the greater of the two, then the difference between Xpeak2 and Valley is compared to the value of Xpeak2 divided, for example, by four. If the difference is greater than the dividend, the Xbutton is set to Down at step **310**. Otherwise, the value of Xbutton is set to Up at step **315**. The comparison described above is provided to ensure that a legitimate valley and two legitimate peaks have been detected, to avoid artifacts. It will be appreciated, given the teachings herein, that other comparison methods or divisors other than four may be used for this purpose.

The Xcompute loop then ends at step **320**. It will be appreciated by those skilled in the art that the foregoing is

a simplified algorithm and does not include compensation for settling, moisture and noise. Noise thresholding may be provided in at least some embodiments, if noise causes the curve to be non-monotonic; settling and moisture may be dealt with in a similar manner.

The Ycompute loop is performed similarly, as noted above. Depending on the particular arrangement desired, and the associated hardware, the X and Y compute processes may be performed sequentially in either order or concurrently.

While the foregoing example describes identification of minima and maxima in the X and Y directions, it will be apparent that an analysis along a diagonal or some other angular direction may be preferred in some instances, and is still within the scope of the present invention.

It will be appreciated that the foregoing describes a new and useful method and apparatus for detecting a plurality of fingers operatively coupled to a touch pad sensor for enabling a variety of mouse-like operations. A second portion of the invention involves using the previously detection methodology to perform various cursor movement and control functions similar to those well known to users of electronic mice and trackballs.

As previously noted, the first finger is most commonly associated, in the prior art, with cursor movement, while various tapping motions [e.g., tap and tap-and-a half] of that first finger have been implemented to perform various control functions. Unlike such prior art, however, various movements (including sequences of taps) of additional fingers or combinations of the first and additional fingers are provided to enable such control functions in the present invention. Depending on the implementation desired, it is also possible to implement a superset of the prior art control functions together with the more robust control function set available with the present invention.

Note that in the preferred embodiment, the user may arbitrarily choose which finger he or she uses as the "first" or "second" or additional fingers. Thus, for example, one user may choose the index finger as the first finger and the middle finger as the second finger, while another user may prefer the reverse or some different combination. In the preferred embodiment, the only distinction between the first, second and additional fingers is the sequence in which they are placed in contact with the touchpad surface, or removed from it. In any case where a second or additional finger or fingers is placed down after a first finger, or multiple fingers, is already in contact with the pad, the newly placed fingers can be in any relationship to those already in contact with the pad, such as to the left, to the right, above or below. The only requirement is that, in the profile of finger-induced capacitances, the profile of the newly placed finger exhibits a zero value or a local minimum on each side of its peak value, in at least one of the X or Y directions, so that it may be distinguished from the other finger(s) in contact with the touchpad.

In particular, the ability of the previously described methodology to recognize multiple fingers allows the first finger to serve, essentially, as the "point" finger, while additional fingers serve as the "click" finger(s). Combinations of the first, second, and perhaps additional fingers can then enable numerous conventional functions to be performed based on the mapping of a variety of sequences of taps or finger movements to a set of conventional pointing device functions, where the pointing device could be a touchpad, mouse, trackball, joystick, or stylus, for example. It will be apparent to those skilled in the art, given the foregoing description, that the present invention can detect, for example, relative movement of the first finger, together with a tap of the second or more fingers at some point, followed either by removal of both fingers, further movement of the first finger, or further movement of both fingers. Such sequences can, essentially, be viewed as a series of scans in which one or more fingers were found to be either present or absent in any given scan, with motion, or lack thereof, of the finger or fingers across the touch sensor interspersed between changes in the number of fingers in contact with the touchpad. The specific sequence can then be analyzed to determine whether only a cursor movement is involved or whether a control function is intended. If a control function is intended, the specific control function can then be identified.

Referring to FIGS. **7A–7F**, there is shown in diagrammatic form an exemplary sequence involving operative coupling of a plurality of fingers with a touch sensor to cause both a cursor movement and a control function. More specifically, FIG. **7A** shows a series of movements of one or more fingers across a touch sensor, including various finger taps. FIGS. **7B–7F** show, for each of the numeric references in FIG. **7A**, an exemplary video display, an exemplary position of one or more fingers on the touchpad, and X and Y finger profiles appropriate to that finger contact. It will be helpful to define certain conventions used in FIGS. **7A–7F** before discussing these figures. In FIG. **7A–7F**, contact between a finger and the touch pad is indicated by a solid circle within the fingertip; an absence of contact between a fingertip and the touch sensor is indicated by the absence of circle within the finger tip. A tap—i.e., an up and down motion—by a finger is indicated by a dashed circle. Movement of the fingers from a first to a second point while in contact with the touch sensor is indicated by a solid arrow. Movement of the fingers from a first to a second point with the fingers not in contact is indicated by a dashed arrow. With these conventions in mind, FIGS. **7A–7F** can be better understood.

In particular, and with reference to FIG. **7A** in combination with FIG. **7B**, an initial series of scans **700** indicates the presence of a single finger in contact with the touch sensor, with the changing X,Y location between **700** and **705** indicating relative motion by the finger across the touch sensor. At **710**, a second finger is detected in contact with the touch sensor, and continues to be operatively coupled to the sensor for several more scans without significant relative motion across the sensor. At **720**, the second finger is removed, while the first finger remains. From **720** until **730** (shown in FIG. **7C**) the first finger continues its relative motion, while at **740** the second finger is again placed down. The scans of the sensor then detect both the first and second finger being moved together across the sensor until the scan at **750**, then both fingers are removed at **755**. Thereafter, both fingers are again placed on the sensor at **760** (shown in FIG. **7D**), where they remain for a few more scans until **770**, at which time they are both removed. Three fingers are placed on the sensor at **780**, and removed a few scans later at **790**. Thereafter, three fingers are placed on the sensor at **800** (FIG. **7E**), moved across the touch sensor for a few scans from **800** to **805**, and are then removed at **810**. Finally, as shown at **820** (FIGS. **7F1–2**), one finger is placed down while the adjacent finger is moved, such as might be desirable for marking text or other functions. When the finger is moved as far as is practicable, the moving finger is picked up at **825** and placed down again at **830** for further movement. The moving finger can be picked up and placed down again as often as desired. Eventually the other, substantially fixed finger is lifted at **835**, causing a "button up" condition.

While the foregoing sequence can be programmed to define any number of cursor movement and control functions, an exemplary definition of the functions associated with such sequences can be the following: For the period from **700** through **705** the relative motion of a single finger can be defined to mean cursor movement for that period, from the beginning point until the relative ending point. During the period **710** to **720**, a second finger is detected and then removed, which is defined in an exemplary embodiment as a single finger tap which may be a "select" function such as selecting one item from a screen menu. During the period **720** until **730**, the single finger again moves the cursor, while at **740** the second finger reappears to enable a different function. The second finger moves across the sensor, together with the first finger, until at **755** both fingers are removed. Again, such sequences—all of which may be regarded as gestures—can be mapped to control functions in numerous ways, but one reasonable definition is that the presence of two fingers engaged in relative motion is a "drag function," such as where an entity was selected by the first tap and dragged to a new location, where it is dropped by the removal of both fingers at **750**.

Then, at **760**, both fingers reappear and remain for a few additional scans until both are removed at **770**. This gesture, which may be considered a "two finger tap," can enable numerous functions, but an exemplary definition is the classical "double-click" of a standard left mouse button, or the click of a middle button on some three button mice, such as those sold by Logitech, Inc., and could, for example, activate a function or application associated with the item to which the cursor is pointing.

Next, the sequence from **780** to **790**, when the three fingers reappear and are then removed, is a "three finger tap", and can be regarded, for example, as a right mouse button click which may, for example, activate a menu specific to the item to which the cursor is pointing. Finally, the sequence from **800** until **810**, in which three fingers reappear, move across the touch sensor and are then removed, may in an exemplary embodiment be seen as a shortcut to a multi-sequence function. For example, such a movement might be defined as a scroll function, which might otherwise require the user to move the cursor to a scroll bar, drag and drop a scroll box, and return the cursor to the working area of the screen. Finally, the sequence from **820** through **830** can be analogized to holding down a mouse button (for example the left mouse button), rolling a mouse whatever distance is convenient for the user, then picking up the mouse (while continuing to hold down the button) and placing the mouse down again at a position convenient for further movement of the mouse. One example of the use of such a sequence is the marking of text. The algorithm for recognizing movement by one "cursor" finger while the other "button" finger is maintained in position is a generalized case of the algorithm shown in FIGS. **5** and **6**, and is described in greater detail in FIGS. **8** and **9**. Other functions which can be implemented with such gestures include an "ink" function (mentioned above), entry of variable values, and use of the sensor in absolute mode.

Referring next to FIGS. **8** and **9**, the generalized case associated with FIGS. 7F1–2, but also applicable to the remaining functions, may be better appreciated. In the exemplary algorithm shown in FIGS. **8** and **9**, a determination is made whether zero, one or two fingers are in contact with the touchpad. Depending on how many fingers are identified, various operations are permitted. It will be appreciated that FIG. **8** is analogous to FIG. **5**, while FIG. **9** is analogous to FIG. **6**. For convenience, steps unchanged from FIGS. **5** and **6** are in most cases referred to by the reference numerals used in those figures.

In FIG. **8**, the process begins in a manner identical to FIG. **5**, starting at step **400** and followed by scanning the conductors and storing the results of the scan in memory at step **405**, followed by Xcompute and Ycompute at steps **430** and **440**, respectively. For this embodiment, Xcompute is shown in FIG. **9**, and Ycompute is identical to Xcompute. At step **850**, a determination is made whether two fingers are in contact with the touchpad by evaluating both Xcompute and Ycompute. If neither Xcompute nor Ycompute indicate the presence of two fingers, the answer is NO and the process drops to step **855**. However, if either the Xcompute routine or the Ycompute routine indicates the presence of two fingers, the answer at step **850** is YES and the process moves to step **860**, where the value of the variable FINGER is set to 2.

If the answer at step **850** was NO, then a determination has to be made at step **855** whether one or no fingers are in contact with the touch sensor. If variables Xfinger and Yfinger do not both equal 1, then the comparison at step **850** is a NO and it is determined that no fingers are in contact with the touch sensor. In this case, the variable FINGER is set to 0 at step **865**. However, if the variables both yield a 1, then a determination is made that one finger is in contact with the sensor, and the variable FINGER is set to 1 at step **870**.

In either event, the process then moves to step **875**, where Xmotion and Ymotion are calculated in a manner identical with FIG. **5**. The process then continues at step **880**, where the variable Finger is compared to the value of FingerPrevious. If the value of Finger differs from the value of FingerPrevious, then a button actuation is assumed to have occurred, and Xmotion and Ymotion are set to zero at step **885**. However, if the value of Finger equals the value of FingerPrevious (i.e., the current number of fingers contacting the pad is the same as in the previous state), then the comparison of step **880** yields a YES, and the process moves to step **890**. At step **890** a comparison is made to determine whether there has been motion in either the X or Y directions. If neither Xmotion nor Ymotion is nonzero, a NO results and the process moves to step **895** where the variable Motion is set to NO. The same results obtains if the process goes through step **885**. However, if either Xmotion or Ymotion is nonzero, a YES results at step **890**, and the process moves to step **900** where the variable Motion is set to YES.

From either step **895** or step **900**, the process moves to step **905**, where a check is made to determine whether ButtonPrevious was up and the number of fingers detected is two. If the answer is NO, the process moves to step **910**. However, if a YES is obtained, the process moves to step **915** where the state of the Button variable is reported to the host as DOWN, and the variable ButtonPrevious is set to Down.

Referring again to step **910**, a check is made to determine whether either of two groups of conditions exist. A YES result may be obtained if ButtonPrevious is DOWN and and the value of the Finger variable is zero; or if ButtonPrevious is Down and the variable Motion is set to YES and the variable Finger is set to one. If none of these conditions exist, a NO result is obtained and the process moves to step **920**. However, if a YES does result, then the process moves to step **925** and reports to the host that Button is Up, while also setting the variable ButtonPrevious to Up.

If a NO resulted at step **910**, at step **920** a comparison is made between variables FingerPrevious and Finger, and the

state of the Motion variable. If FingerPrevious is the same value as Finger, and Motion has occurred (i.e., Motion is Yes), the process moves to step **930** and both Xmotion and Ymotion are reported. The process then moves to step **935**. However, if the comparison at step **920** yields a No, the process moves directly to step **935**. At step **935**, the value of XabsolutePrevious is set to the value of Xabsolute, the value of YabsolutePrevious is set to the value of Yabsolute, and the value of FingerPrevious is set to the value of Finger. The process then moves to step **940**, where it recycles by jumping back to start.

Referring next to FIG. **9**, the Xcompute process is shown in detail for the generalized case shown in FIG. **8**. As noted previously, the Ycompute process is identical and is therefore not shown separately. The process of FIG. **9** is identical to that shown in FIG. **6** up through step **290**, and the preceding steps will therefore not be discussed again. However, if a No results from the comparison at step **290**, a determination is made that no fingers are in contact with the pad. This causes the variable Xfinger to be set to zero at step **970**.

Steps **295** and **305** are unchanged from FIG. **6** and will not be discussed further. However, if a No results from the comparison at step **305**, then a determination is made that one finger is in contact with the sensor, and the value of the variable Xfinger is set to one at step **975**. By contrast, if the result at step **305** is a Yes, then a determination is made that two fingers are in contact with the sensor and the variable Xfinger is set to two at step **980**. Regardless of the number of fingers in contact with the sensor, the process moves to step **320** and ends until the next cycle.

Another function achievable with the detection method and apparatus of the present invention may be referred to as edge lock. Because a touch sensor can detect, in absolute terms, where on the sensor the operative coupling occurs, it is possible to detect that one or more fingers have reached the edge of the sensor. In some instances, the user intends to continue the movement he was engaged in when he hit the edge; for example, a drag function involving two fingers, in which the two fingers hit the edge before the object being dragged has reached its destination. In the environment of a mouse, the user simply picks up the mouse while holding the button down, puts it back down and moves again. In the context of a touchpad, however, removal of the two fingers may be perceived as termination of the function even though such termination was not intended. To avoid such problems, the function in which the user was engaged at the time the fingers hit the edge may remain active—i.e., locked in—for a delay period. If the fingers are placed down on the touchpad within the delay period, the user continues with the earlier function. If the user does not place down the fingers within a predefined delay, the function is terminated and a new function begins when the user again places the fingers in operative contact with the sensor.

It will be appreciated from the foregoing that the present invention allows numerous multi-finger gestures to be detected and converted to mouse-related functions for moving a cursor and control of operating environments or applications programs. However, while some exemplary functions and exemplary definitions for particular sequences have been provided above, it is to be understood that the present invention is not limited to the association of a particular function with a particular sequence or to any particular set of functions. Instead this aspect of the invention is directed to the ability to identify and process various sequences in which one or more fingers are either absent or present, interspersed with motion or lack of motion of the finger or fingers across the touch sensor, to evaluate those sequences either locally or via software on the host, and to report appropriate signals to cause cursor movements or control functions to occur in applications programs or operating environments.

Having fully described various embodiments of the present invention, numerous alternatives and equivalents which do not depart from the invention will be apparent to those skilled in the art. It is therefore intended that the invention not be limited by the foregoing description, but only by the appended claims.

What is claimed is:

1. A method for detecting the operative coupling of multiple fingers to a touch sensor involving the steps of

scanning the touch sensor to (a) identify a first maxima in a signal corresponding to a first finger, (b) identify a minima following the first maxima, (c) identify a second maxima in a signal corresponding to a second finger following said minima, and

providing an indication of the simultaneous presence of two fingers in response to identification of said first and second maxima.

2. The method of claim **1** further including the step of causing a pointing device click function to occur in response to the detection of at least a second maxima.

3. The method of claim **1** further including the step of enabling a "drag" function to occur in response to the detection of at least a second maxima.

4. The method of claim **1** further including the step of enabling a "select" function in response to the detection of at least a second maxima.

5. The method of claim **1** further including the step of enabling an "ink" function in response to the detection of at least a second maxima.

6. The method of claim **1** wherein said touch sensor includes a plurality of lines, said maxima being a largest local variation in a signal value on one of said lines due to capacitive coupling of a finger.

7. The method of claim **6** wherein said maxima are peaks.

8. The method of claim **1** further comprising the step of comparing a distance between said first maxima and said second maxima to a predefined threshold.

9. The method of claim **1** further comprising the steps of:

providing a first control function in response to the detection of the movement of two fingers:

detecting the reaching of an edge of said touch sensor by said two fingers;

detecting a first time corresponding to the removal of said fingers from said touch sensor;

detecting a second time corresponding to the replacement of said two fingers on said touch sensor; and

continuing said first control function if said first and second times are within a predetermined time limit of each other.

10. The method of claim **1** further comprising the step of:

detecting a distance between said first and second maxima.

11. The method of claim **1** further comprising the step of:

providing a drag control function in response to detecting a movement in substantial unison of two said fingers.

12. The method of claim **1** further comprising the step of:

providing a click function in response to the removal and reappearance of said second maxima within a predetermined period of time.

13. The method of claim 1 further comprising the steps of:

detecting a movement of said first maxima;

detecting a removal and replacement of said maxima within a predetermined time period;

controlling a cursor function in response to said movement of said first maxima; and

providing a control function in response to said removal and replacement of said second maxima.

14. The method of claim 1 further comprising the step of:

selecting an appropriate control function based on a combination of a number of fingers detected, an amount of time said fingers are detected, and any movement of said fingers.

15. The method of claim 1 further comprising the step of determining if said first and second maxima are within 5 centimeters, and only providing said indication of the presence of two fingers if said first and second maxima are within 5 centimeters.

16. The method of claim 1 further comprising the step of calculating first and second centroids corresponding to said first and second fingers.

17. The method of claim 1 wherein said first and second maxima are required to be higher than a first threshold, and said minima is required to be less than a second threshold.

18. A touch sensor for detecting the operative coupling of multiple fingers comprising:

means for scanning the touch sensor to (a) identify a first maxima in a signal corresponding to a first finger, (b) identify a minima following the first maxima, and (c) identify a second maxima in a signal corresponding to a second finger following said minima, and

means for providing an indication of the simultaneous presence of two fingers in response to identification of said first and second maxima.

19. The touch sensor of claim 18 further comprising:

means for selecting an appropriate control function based on a combination of a number of fingers detected, an amount of time said fingers are detected, and any movement of said fingers.

20. The touch sensor of claim 18 wherein said touch sensor includes a plurality of lines, said maxima being a largest local variation in a signal value on one of said lines due to capacitive coupling of a finger.

21. The touch sensor of claim 18 wherein said maxima are peaks.

22. The touch sensor of claim 18 further comprising means for comparing a distance from said first maxima to said second maxima to a predefined threshold.

23. The touch sensor of claim 18 further comprising:

means for providing a first control function in response to the detection of the movement of two fingers:

means for detecting the reaching of an edge of said touch sensor by said two fingers;

means for detecting a first time corresponding to the removal of said fingers from said touch sensor;

means for detecting a second time corresponding to the replacement of said two fingers on said touch sensor; and

means for continuing said first control function if said first and second times are within a predetermined time limit of each other.

24. The touch sensor of claim 18 further comprising:

means for detecting a distance between said first and second maxima.

25. The touch sensor of claim 18 further comprising:

means for providing a drag control function in response to detecting a movement in substantial unison of two said fingers.

26. The touch sensor of claim 18 further comprising:

means for providing a click function in response to the removal and reappearance of said second maxima within a predetermined period of time.

27. The touch sensor of claim 18 further comprising:

means for detecting a movement of said first maxima;

means for detecting a removal and replacement of said maxima within a predetermined time period;

means for controlling a cursor function in response to said movement of said first maxima; and

means for providing a control function in response to said removal and replacement of said second maxima.

28. The touch sensor of claim 18 further comprising:

means for selecting an appropriate control function based on a combination of a number of fingers detected, an amount of time said fingers are detected, and any movement of said fingers.

29. The sensor of claim 18 further comprising means for determining if said first and second maxima are within 5 centimeters, and only providing said indication of the presence of two fingers if said first and second maxima are within 5 centimeters.

30. The sensor of claim 18 further comprising means for calculating first and second centroids corresponding to said first and second fingers.

31. The sensor of claim 18 wherein said first and second maxima are required to be higher than a first threshold, and said minima is required to be less than a second threshold.

* * * * *

EXHIBIT G

IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF CALIFORNIA

ELANTECH DEVICES CORP., a corporation existing under the laws of Taiwan, R.O.C.,

Plaintiff,

v.

SYNAPTICS, INC., a Delaware corporation; and AVERATEC, INC., a California corporation,

Defendants.
_______________________________/

No. C 06-01839 CRB

CLAIM CONSTRUCTION ORDER

Elantech Devices Corp. ("Elantech") filed suit against Synaptics, Inc. ("Synaptics") for infringement of U.S. Patent No. 5,825,352 ("the '352 patent"). Synaptics counterclaimed for infringement of U.S. Patents No. 5,880,411 ("the '411 patent"), No. 5,943,052 ("the '052 patent"), No. 5,543,592 ("the '592 patent"), and No. 6,380,931 ("the '931 patent"). The Court will construe eight claim terms selected by the parties.

BACKGROUND

I. The '411 Patent

The '411 patent, entitled "Object Position Detector With Edge Motion Feature and Gesture Recognition," discloses a method to enable a touchpad to recognize finger contact, movement, and drag gestures, and to emulate various mouse functions. The patent was

issued March 9, 1999, and by assignment, Synaptics is the owner of the entire right, title, and interest of the '411 patent.

The '411 patent contains only one of the claim terms to be construed: "incrementally move." The relevant patent claims are directed to a method for extrapolating cursor motion once the user reaches the edge of a touchpad.[1] The general goal of the relevant claims is to detect when the user wants to move the cursor to a position that is beyond the limited bounds of the touchpad and to move the cursor accordingly–this is called cursor "edge motion." '411 patent at 5:9-10.

II. The '931 Patent

The '931 patent, entitled "Object Position Detector With Edge Motion Feature and Gesture Recognition," discloses a method to enable a touchpad to recognize tap gestures and emulate various mouse functions. The patent was issued April 30, 2002, approximately three years after the '411 patent, and by assignment, Synaptics is the owner of the entire right, title, and interest of the '931 patent.

The '931 patent contains three of the claim terms to be construed: (1) "initiating a signal to the host indicating the occurrence of said tap gesture;" (2) "maintaining said signal for a predetermined period of time;" and (3) "detecting in which of at least one corner of the touch-sensor pad said tap gesture occurred." The first two claim terms are related and are generally directed to "a method for recognizing a tap gesture made on a touch-sensor pad."[2] The patent claim relevant to the third claim term is directed to detecting the occurrence of a tap gesture in a particular corner. The patentee asserts that the invention allows for greater structural design flexibility and efficiency. The patentee described methods of recognizing tap gestures that were known in the prior art, and asserted that the prior art systems were slower, less intuitive for users, and more likely to cause user strain.

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[1]The term to be construed is present in claims 40, 46, 53, and 59.

[2]The first two terms to be construed are present in claims 1 and 7. The third term is present in claim 5.

United States District Court
For the Northern District of California

III. The '352 Patent

The '352 patent, entitled "Multiple Fingers Contact Sensing Method for Emulating Mouse Buttons and Mouse Operations on a Touch Sensor Pad," discloses a method for recognizing the presence of multiple fingers on a touchpad and emulating various mouse function; the patent also discloses a touchpad with such capabilities. The patent was issued October 20, 1998, and by assignment, Elantech is the owner of the entire right, title, and interest of the '352 patent.

The '352 patent contains four of the claim terms to be construed: (1) "scanning the touch sensor" or "means for scanning the touch sensor to . . . ;" (2) "*scanning the touch sensor to* . . . identify a first maxima in a signal corresponding to a first finger;" (3) "*scanning the touch sensor to* . . . identify a minima following the first maxima;" and (4) "*scanning the touch sensor to* . . . identify a second maxima in a signal corresponding to a second finger following said minima." The claims are directed to "a method for detecting the operative coupling of multiple fingers to a touch sensor."[3] Generally, the goal of the method is to detect the presence of multiple fingers on a touch sensor and emulate mouse functions. The patentee described methods of emulating mouse functions using a touchpad that were known in the prior art, and asserted that these systems were more stressful and less intuitive than using a mouse.

DISCUSSION

I. Legal Standard for Claim Construction

Claim construction is a matter of law for the court to decide. Markman v. Westview Instruments, Inc., 52 F.3d 967, 979 (Fed. Cir. 1995), aff'd, 517 U.S. 370, 372 (1996). When construing claims, a court first looks to intrinsic evidence of record, and thereafter, if appropriate, to extrinsic evidence. Vitronics Corp. v. Conceptronic, Inc., 90 F.3d 1576, 1582 (Fed. Cir. 1996). Intrinsic evidence comprises the patent claims, the specification, and, if entered into evidence, the prosecution history. Id. Intrinsic evidence also comprises the prior art cited in a patent or during the prosecution. Kumar v. Ovonic Battery Co., 351 F.3d

[3]The terms to be construed are present in claims 1 and 18.

1364, 1368 (Fed. Cir. 2003). In most cases, the intrinsic evidence alone will determine the proper meaning of the claim terms. Vitronics, 90 F.3d at 1583.

When construing claims, the analysis begins with, and must focus on, the language of the claims themselves. Interactive Gift Exp., Inc. v. Compuserve Inc., 256 F.3d 1323, 1331 (Fed. Cir. 2001). If the claim language is clear on its face, then the rest of the intrinsic evidence is considered only for whether any deviation from the plain meaning is specified. Id. Deviation may be warranted if, for example, the patentee has "chosen to be his own lexicographer," or if the patentee has disclaimed a certain portion of the claim scope that would otherwise be afforded by the plain meaning. Id. (citations omitted). Where the claim language is not clear, other intrinsic evidence is used to resolve the lack of clarity. Id.

Generally, a court gives the words of a claim their ordinary and customary meaning. Phillips v. AWH Corp., 415 F.3d 1303, 1312 (Fed. Cir. 2005) (en banc). The "ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention, i.e., as of the effective filing date of the patent application." Id. at 1313. The context in which a word appears in a claim informs the construction of that word. Id. at 1314. Where there are several common meanings, the patent disclosure "serves to point away from the improper meanings and toward the proper meanings." Brookhill-Wilk 1, LLC v. Intuitive Surgical, Inc., 334 F.3d 1294, 1300 (Fed. Cir. 2003) (citation omitted). If more than one definition is consistent with the usage of a term in the claims, the term may be construed to encompass all consistent meanings. Texas Digital Systems, Inc. v. Telegenix, Inc., 308 F.3d 1193, 1203 (Fed. Cir. 2002).

Other claims of the patent in question "can also be valuable sources of enlightenment as to the meaning of a claim term." Phillips, 415 F.3d at 1314. Because claim terms are normally used consistently throughout the patent, "the usage of a term in one claim can often illuminate the meaning of the same term in other claims." Id. The presence of a dependent claim that adds a particular limitation gives rise to a presumption that the limitation in question is not present in the independent claim. Id. at 1315.

United States District Court
For the Northern District of California

Claims must be read in light of the specification. Markman, 52 F.3d at 979. The specification "is the single best guide to the meaning of a disputed term." Vitronics, 90 F.3d at 1582. Where a claim term has multiple yet potentially consistent, definitions, the rest of the intrinsic record, beginning with the specification, provides further guidance. Brookhill-Wilk, 334 F.3d at 1300. If the patentee explicitly defined a claim in the specification, that definition trumps the ordinary meaning of the term. CCS Fitness v. Brunswick Corp., 288 F.3d 1359, 1366 (Fed. Cir. 2002). The specification may define a term by implication. Phillips, 415 F.3d at 1321. The specification may also reveal a disclaimer of the claim scope by indicating that the invention and all of its embodiments only occupy part of the broad meaning of a claim term. SciMed Life Sys. v. Advanced Cardiovascular Sys., 242 F.3d 1337, 1343-44 (Fed. Cir. 2001).

It is error, however, to import a limitation from the specification into the claim. Liebel-Flarsheim Co. v. Medrad, Inc., 358 F.3d 898, 905 (Fed. Cir. 2004). Standing alone, an embodiment disclosed in the specification does not limit the claims. Id. at 906. Even when the specification describes only a single embodiment, the claims of the patent are not to be construed as restricted to that embodiment unless the patentee demonstrates a clear intention to limit the claim scope using "words or expressions of manifest exclusion or restriction." Teleflex, Inc. v. Ficosa N. Am. Corp., 299 F.3d 1313, 1327 (Fed. Cir. 2002). Absent clear statements of scope, courts are constrained to follow the language of the claims and not that of the written description provided by the specification. Id. at 1328; see also Specialty Composites v. Cabot Corp., 845 F.2d 981, 987 (Fed. Cir. 1988) (stating a limitation should not be read into the claims unless a specification so requires).

Conversely, a construction that excludes a preferred embodiment is "rarely, if ever, correct." Pfizer Inc. v. Teva Pharm., USA, Inc., 429 F.3d 1364, 1374 (Fed. Cir. 2005) (quoting Sandisk Corp. v. Memorex Products, Inc., 415 F.3d 1278, 1285 (Fed. Cir. 2005)). Courts require highly persuasive evidence that the claims do not encompass a preferred embodiment. Vitronics, 90 F.3d at 1583.

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II. Construction of the Disputed Terms

The following analysis considers as intrinsic evidence the claims, the specification, and the prosecution history.

A. The '411 Patent

The parties have requested the Court to construe the term "incrementally move."

1. "Incrementally move"

Claims 40, 46, 53, and 59 of the '411 patent contain the term "incrementally move." For example, claim 40 recites, in relevant part:

> . . . generating second cursor motion signals different from said first cursor motion signals if said object has moved into said outer region of said sensing plane, said second cursor motion signals for causing said cursor to <u>incrementally move</u> on the display screen a selected distance in a direction representing the difference between a fixed reference point on said sensing plane and said present position of said object on said sensing plane. . . .

'411 patent at 62:53-60 (emphasis added).

Elantech proposes a construction of "movement defined by the second component of Equations 12 and 13 in the '411 patent, namely, $S(X_{cur}-X_{center})$ and $S(Y_{cur}-Y_{center})$." Limitations in narrow claims dependent from claim 40 may not be imported into the broad language of claim 40. The limitation in dependent claim 44 sets the "fixed reference point" of claim 40 as the center of the sensing plane. Dependent claim 45 includes a speed variable in the calculation of the incremental motion of claim 40. A construction of "movement defined by the second component of Equations 12 and 13 in the '411 patent, namely, $S(X_{cur}-X_{center})$ and $S(Y_{cur}-Y_{center})$" would impermissibly import limitations from dependent claims into a broad claim.

Moreover, Elantech's very narrow construction limiting the claims to one embodiment ignores the explicit statement in the specification of the '411 patent: "[t]hose of ordinary skill in the art will recognize that a linear proportionality is described by the above equation. As used herein, 'proportionality' means that the signal generated is a monotonic function. Those of ordinary skill in the art will recognize that other monotonic functions, including but not limited to inverse proportionality, and non-linear proportionality such as logarithmic or

exponential functions, could be employed in the present invention without departing from the principles disclosed herein." '411 patent at 31:29-38. This statement immediately follows an explanation of how Equations 12 and 13 might be applied within an algorithm in the preferred embodiment. '411 patent at 30:65-67–31:1-29.

The term "incrementally move" means "move in calculated increments."

B. The '931 Patent

The parties have requested the Court to construe the following three terms:

(1) "initiating a signal to the host indicating the occurrence of said tap gesture;"

(2) "maintaining said signal for a predetermined period of time;" and

(3) "detecting in which of at least one corner of the touch-sensor pad said tap gesture occurred."

The first and second terms appear together in the claims, and both are used to describe steps concerned with transmission of a signal; these terms will be analyzed together.

1. "Initiating a signal to the host indicating the occurrence of said tap gesture" and "Maintaining said signal for a predetermined period of time"

Claims 1 and 7 of the '931 patent both contain the term "initiating a signal to the host indicating the occurrence of said tap gesture" and the term "maintaining said signal for a predetermined period of time." Claim 1 recites, in relevant part:

> . . . . initiating a signal to the host indicating the occurrence of said tap gesture if the amount of time said conductive object is present on said touch pad is less than said reference amount of time and if the amount of motion made by said conductive object while it is present on said touch pad is less than said reference amount of motion; and maintaining said signal for a predetermined period of time.

'931 patent at 53:4-12 (emphasis added).

For the term "initiating a signal to the host indicating the occurrence of said tap gesture," Synaptics proposes a construction of "initiating the transmission of a set of data to a computer, or other device that can take as input the output of a touch-sensor pad, that indicates that a tap gesture has occurred on the touch-sensor pad." Elantech proposes a

construction of "outputting to the host a high state of a signal that has a low and a high state, where the high signal state represents that a tap gesture occurred on the touch-sensor pad."

For the term "maintaining said signal for a predetermined period of time," Synaptics proposes a construction of "to continue, retain, or repeat the signal for a period of time that was determined before." Elantech proposes a construction of "continuously outputting the high state of the signal only for a predetermined time period (i.e., changing the signal state from high to low at the end of the predetermined time period)." In other words, Elantech asserts that a "signal" has only two states and that "maintaining" the signal can only be accomplished by continuous output of the signal, while Synaptics asserts a flexible construction of the word "signal" as "the transmission of a set of data" and that "maintaining" a signal may be accomplished in several ways.

The claims and the specification do not support a construction where a "signal" can only represent a low state and a high state. The word "signal" is used broadly throughout the '931 patent. As used in claim five, a "signal" is able to indicate both that a tap gesture occurred and *where* the tap gesture occurred. This type of complex data communication is beyond the capacity of a signal that only has a low state and a high state, and there is nothing in the claims to indicate that the word "signal" in claim five should be construed differently than the word "signal" in claims one or seven. The word "signal" is also used in other contexts throughout the '931 patent: a packetized "10-bit wide digital signal," '931 patent at 13:64-65, and "a monotonic function." '931 patent at 31:59-60. In their opposition brief, Elantech argues that every reference to the word "signal" that relates to gesture recognition refers only to the "OUT" signal described in Fig. 15a-e. However, the "OUT" signal described in Fig. 15a-e of the specification is the output of tap unit 280, which is only one component in the circuitry. Id. at 34:23-29. The "OUT" signal is not the ultimate signal which is sent to the host, as described in the relevant claims; it is only used to convey information about (1) the fact that a tap gesture occurred, and (2) which button click should be emulated–left, middle, or right. Id. at 35:26-27.

There is little in the intrinsic evidence that describes exactly how a "signal" is "maintained." Nothing in the claims addresses this point, but one clue arises in the description of the flowchart that illustrates the operation of the tap unit: "[s]tep 334 also sets the Suppress flag to True to cause the virtual button signal to stay low for a short period." '931 patent at 43:1-2; Fig. 17B. The fact that setting a flag to a value of True could cause a signal to "stay low"–to maintain a particular value–"for a short period of time" indicates that there is more than one way of "maintaining" a signal. There is no evidence to support Elantech's construction that a signal is "maintained" only by continuously outputting the signal.

The term "initiating a signal to the host indicating the occurrence of said tap gesture" means "initiating the transmission of a set of data to a computer, or other device that can take as input the output of a touch-sensor pad, that indicates that a tap gesture has occurred on the touch-sensor pad." The term "maintaining said signal for a predetermined period of time" means "to continue, retain, or repeat the signal for a period of time that was determined before."

2. "Detecting in which of at least one corner of the touch-sensor pad said tap gesture occurred"

Claim 5 of the '931 patent recites, in relevant part:

> . . . <u>detecting in which of at least one corner of the touch-sensor pad said tap gesture occurred</u> . . .

<u>Id.</u> at 53:29-30 (emphasis added).

Synaptics proposes a construction of "detecting that a tap gesture has occurred in at least one corner, the identity of which is distinguished in some way from other corners of the touch-sensor pad." Elantech proposes a construction of "after detecting the occurrence of the tap gesture, separately detecting in which of at least one corner of the touch-sensor pad the tap gesture occurred." In other words, Synaptics asserts that the single event of the detection of the occurrence of the tap gesture also provides information on where the tap gesture occurred, while Elantech asserts that the detection of where the tap gesture occurred is a separate event from the detection of the occurrence of the tap gesture.

Claim five requires that the first two detection steps be complete by the time the last step of the method is executed, since it is not possible to send a signal "indicating the occurrence of said tap gesture and in which of at least one corner of said touch-sensor pad said tap gesture occurred" unless one has already detected the occurrence of said tap gesture and detected in which of at least one corner of said touch-sensor pad said tap gesture occurred. However, there is nothing in the claim language to indicate that the two detection steps could not occur simultaneously.[4] Elantech argues that "[i]t would be impossible to detect in which of at least one corner of the touch-sensor pad said tap gesture occurred if the tap gesture has not previously been detected," and cites cases where an order has been imposed upon steps in a method. However, in all the cases cited there is a modifying adjective present in one step of the method that refers to an action taken in a previous step–an explicit link that requires the imposition of an order as between the two steps.[5] The cited cases are therefore distinguishable because in the second detection step here there is no adjective modifying the phrase "tap gesture" that refers to an action taken in the first detection step.

The term "detecting in which of at least one corner of the touch-sensor pad said tap gesture occurred" means "detecting that a tap gesture has occurred in at least one corner, the identity of which is distinguished in some way from other corners of the touch-sensor pad."

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[4]The specification and the figures illustrate in meticulous detail the steps involved in detecting the occurrence of a tap gesture and (assuming that it was a corner tap) detecting in which corner the tap gesture occurred. '931 patent at 42:34-44:33; Fig. 17B-C. Step 326 is where the tests are performed to determine whether a tap gesture has occurred, and step 348 is where the tests are performed to determine whether a corner tap has occurred. As described in the specification and figures, there are many interleaving steps, however, there is no way to arrive at step 348 without first proceeding through step 326. Nevertheless, an order cannot be imposed as between the two detection steps since there is no law to support such a ruling where the plain words of the claim impose no such order.

[5]Elantech cites Combined Sys., Inc. v. Def. Tech. Corp. of Am. and Fed. Labs., 350 F.3d 1207, 1210 (Fed. Cir. 2003) (claim 1 of the '562 patent recites a step of "*forming folds* in said tubular sock-like projectile body" and then a step of "inserting said *formed folds* of said tubular sock-like projectile body") (emphasis added); see also Mantech Envtl. Corp. v. Hudson Envtl. Servs., Inc., 152 F.3d 1368, 1376 n.13 (Fed. Cir. 1998) (where claim 1 of the '483 patent recites a step of "providing a treating flow of *acetic acid* . . . into said groundwater region" and then a step of "introducing . . . an aqueous solution of ferrous ion into said groundwater region, for mixing with said *acidified groundwater*") (emphasis added).

C. The '352 Patent

The parties have requested the Court to construe the following four terms:

(1) "scanning the touch sensor" or "means for scanning the touch sensor to ...;"

(2) "*scanning the touch sensor to* ... identify a first maxima in a signal corresponding to a first finger;"

(3) "*scanning the touch sensor to* ... identify a minima following the first maxima;" and

(4) "*scanning the touch sensor to* ... identify a second maxima in a signal corresponding to a second finger following said minima."

The latter three terms are used in the context of scanning the touch sensor and together describe the process of recognizing the presence of one or more fingers on the touch sensor; these three terms will be analyzed together.

1. "Scanning the touch sensor"

Claims 1 and 18 of the '352 patent both contain the term "scanning the touch sensor." Claim 1 recites, in relevant part:

> . . . . scanning the touch sensor *to (a) identify a first maxima in a signal corresponding to a first finger, (b) identify a minima following the first maxima, (c) identify a second maxima in a signal corresponding to a second finger following said minima. . . .*

'352 patent at 16:16-20 (emphasis added).

Elantech proposes a construction of "examining information associated with the touch sensor." Synaptics contends that the phrase should be construed to mean "measuring the traces in the touch sensor and assigning them to a sequence corresponding to their physical order on the touch sensor." In other words, Elantech asserts a broad construction of "scanning the touch sensor" that is not tied to any particular touch sensor technology and that the data obtained from scanning the touch sensor need not be structured or ordered in any way. By contrast, Synaptics asserts that the "touch sensor" must be limited to capacitive devices using traces and that each capacitance value obtained from scanning the touch sensor must be associated with information representing the particular position on the touch sensor where the value was detected; Synaptics does not argue that the traces must be sensed in a

sequential fashion and agrees that, as disclosed by the '352 patent, all traces may be sensed simultaneously.

There is nothing in the language of claims 1 or 18 that require a construction of a "touch sensor" that includes traces. In fact, claim 6, which is dependent from (and thus narrower than) claim 1, includes a limitation on the touch sensor "wherein said touch sensor includes a plurality of lines." Furthermore, the specification explicitly states that "[t]he present invention may be implemented based on any conventional touch sensing technology, although an exemplary embodiment involves the use of a capacitive touch sensing device." '352 patent at 2:20-24. Synaptics argues that because the parties have agreed on a construction of the term "operative coupling" to mean "electrical finger-induced effect," the claims must then be limited to methods and systems that measure such an electrical phenomenon. Although this may be true, there is no evidence that methods and systems that detect electrical finger-induced effect necessarily require traces.

Elantech's construction of "examining information associated with the touch sensor," by contrast, is far too broad, as such words could be interpreted to include determining the chemical composition of the surface of the touch sensor, the manufacture date of the touch sensor, or the power consumption metrics of the touch sensor. The term "scanning the touch sensor" only appears in claims 1 and 18, and the term only appears in conjunction with the purpose of seeking to detect operative coupling. '352 patent at 16:16-20, 17:29-34. As stated in Elantech's own reply brief, the purpose of "scanning the touch sensor" is "to identify finger presence."

The term "scanning the touch sensor" means "measuring the values generated by a touch sensor to detect operative coupling and determining the corresponding positions at which measurements are made."

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2. "*Scanning the touch sensor* to (a) identify a first maxima in a signal corresponding to a first finger, (b) identify a minima following the first maxima, (c) identify a second maxima in a signal corresponding to a second finger following said minima"

Claims 1 and 18 of the '352 patent both contain the three terms "identify a first maxima in a signal corresponding to a first finger," "identify a minima following the first maxima," and "identify a second maxima in a signal corresponding to a second finger following said minima." Claim 1 recites, in relevant part:

> . . . . *scanning the touch sensor to* (a) identify a first maxima in a signal corresponding to a first finger, (b) identify a minima following the first maxima, (c) identify a second maxima in a signal corresponding to a second finger following said minima. . . .

Id. at 16:16-20 (emphasis added).

For the term "identify a first maxima in a signal corresponding to a first finger," Elantech proposes a construction of "identify a first peak value in a finger profile obtained from scanning the touch sensor." Synaptics proposes a construction of "measuring the trace values of the touch sensor corresponding to a first finger and determining the point at which the measured values cease to increase and begin to decrease."

For the term "identify a minima following the first maxima," Elantech proposes a construction of "identify the lowest value in the finger profile that occurs after the first peak value, and before another peak value is identified." Synaptics proposes a construction of "measuring the trace values of the touch sensor following, in scan order, said minima and determining the point at which the measured values cease to decrease and begin to increase."

For the term "identify a second maxima in a signal corresponding to a second finger following said minima," Elantech proposes a construction of "after identifying the lowest value in the finger profile, identify a second peak value in the finger profile." Synaptics proposes a construction of "measuring the trace values corresponding to a second finger following, in scan order, said minima and determining the point at which the measured values cease to decrease and begin to increase."

In other words, Elantech asserts that a "maxima" or "minima" represents only the maximum or minimum capacitance value measured across a finger profile; a "maxima" or "minima" does not refer in any way to the particular position[s] on the touch sensor where the maximum or minimum capacitance values appear. Synaptics asserts that a "maxima" or "minima" represents not only the capacitance measured at that one trace, but also the particular position on the touch sensor where that maximum or minimum level of capacitance was detected across the finger profile. Synaptics also asserts that within a finger profile, a "maxima" or "minima" can only appear at one precise point on the touch sensor, and so when a maximum or minimum capacitance value, as measured across a finger profile, appears at multiple traces (a plateau), the "maxima" or "minima" appears at the last trace that is included within that plateau region. Finally, Synaptics asserts that, in accordance with its construction of "scanning the touch sensor," a limitation must be imposed upon the location in which a minima following a first maxima or a second maxima following a minima may appear.

Synaptics bases its argument on the detailed mechanics of the embodiment described in the specification and in Fig. 5-6. There is support in the claims for a construction of the terms "maxima" and "minima" as data objects that have position information, as well as a capacitance value;[6] however, there is no support in the intrinsic evidence for a construction of either the term "maxima" or the term "minima" wherein the position information can only relate to a precise point–a single X axis value and a single Y axis value. Such a construction could twist the ordinary meaning of a "maxima" or a "minima" so as to exclude a plateau maxima, where the maximum capacitance value appears over a range of X axis values and/or Y axis values.

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[6]Claim 8 adds a step to the method of claim 1 of "comparing a distance between said first maxima and said second maxima to a predefined threshold." '352 patent at 16:41-43. Claim 10 adds the step of "detecting a distance between said first and second maxima." '352 patent at 16:57-59.

Claim 15 adds the step of "determining if said first and second maxima are within 5 centimeters." '352 patent at 17:17-18-43. Claim 13 also adds a step of "detecting a movement of said first maxima." '352 patent at 17:2.

The term "identify a first maxima in a signal corresponding to a first finger" means "identify a first peak value in a finger profile obtained from scanning the touch sensor." The term "identify a minima following the first maxima" means "identify the lowest value in the finger profile that occurs after the first peak value, and before another peak value is identified." The term "identify a second maxima in a signal corresponding to a second finger following said minima" means "after identifying the lowest value in the finger profile, identify a second peak value in the finger profile."

IT IS SO ORDERED.

Dated: April 6, 2007

CHARLES R. BREYER
UNITED STATES DISTRICT JUDGE

EXHIBIT A

JOINT CLAIM CONSTRUCTION CHART

Claim Terms	Synaptics Claim Construction	Elantech Claim Construction
1. "arithmetic unit"	"a functional component of a computer system that performs arithmetic operations"	
2. "gesture"	"finger or object action that communicates an input to a device"	Elantech does not believe this term should be construed alone, but should be construed as part of a larger phrase in which it is recited. See below. To the extent "gesture" is construed alone, Elantech believes it should mean: "movement of a finger or object, either on a surface or in the air"
3. "capacitance profile(s)"	"capacitive information on conductive lines"	Elantech does not believe this term should be construed alone, but should be construed as part of a larger phrase in which it is recited. See below. To the extent "capacitance profile(s)" is construed alone, Elantech believes it should mean: "a complete set of capacitance measurements in an X or Y direction"
4. "developing capacitance profiles" "develop a first capacitance profile" "develop at least one capacitance profile" "develop a second capacitive profile"	"sensing and quantifying capacitive information on conductive lines"	"simultaneously measuring/measure the capacitance on all sensor traces in an X direction or a Y direction"
5. "identifying a simultaneous presence of at least two user input objects"	"determining that two objects or fingers are on or near the touch pad"	"recognizing a second-finger tap"
6. "examining said capacitance profiles to determine an occurrence of a single gesture" "examine said first capacitance profile to determine an occurrence of a single gesture" "examine at least one capacitance profile to determine an occurrence of a single gesture"	"processing the capacitance profile information to determine that a gesture has occurred"	"computing/compute the centroid (i.e., X, Y position) and pressure (i.e., Z value) information and comparing/compare (X, Y, Z) values to recognize a second-finger tap"
7. "single gesture resulting from the	"one gesture (defined above as "finger or object action that communicates an input to a device")	"a second-finger tap (i.e., a two-finger gesture in which one finger remains resting on the pad while

JOINT CLAIM CONSTRUCTION CHART

simultaneous presence of the at least two user input objects" "single gesture resulting from the simultaneous proximity of at least two user input objects" "single gesture resulting from the simultaneous proximity of at least two input objects"	resulting from at least two objects or fingers on or near the touchpad"	another finger taps to one side of the primary finger)"
8. "indicating the occurrence of said single gesture" "indicate the occurrence of said single gesture"	"transmitting information to another module, routine, function, or device that indicates that a gesture has occurred based upon the simultaneous presence of at least two user input objects"	"indicating the occurrence of a second-finger tap"
9. "signal representing a simulated mouse button click" "signal representing a simulated mouse action" "simulated mouse action"	"a signal that represents to the system a mouse button click" "a signal that represents to the system a mouse action"	"a value of LEFT or RIGHT denoting a second-finger tap"
10. "developing capacitance profiles in both said X and Y directions"	"sensing and quantifying capacitive information on conductive lines running in a first direction and in a second direction"	"simultaneously measuring the capacitance on all sensor traces individually in both an X direction and a Y direction"
11. "capacitive sensor"	"a device with a plurality of conductive lines that senses capacitive information"	Elantech believes no construction is necessary. To the extent any construction is given to this term, it simply means a sensor that senses capacitance.
12. "sensing circuitry"	"an interconnection of electrical elements that is used in the sensing of some phenomena"	Elantech believes no construction is necessary.
13. "configured to generate outputs based on the capacitance"	"set to produce information based on the measured capacitance"	Elantech believes no construction is necessary.
14. "button press"	"pressing a button"	Elantech believes no construction is necessary.
15. "simultaneous presence" "simultaneous proximity"	"objects or fingers that are on or near the touchpad"	Elantech does not believe this term should be construed alone, but should be construed as part of a larger phrase. See above.

EXHIBIT C

EXHIBIT C: SYNAPTICS' IDENTIFICATION OF REFERENCES/EVIDENCE

Claim Terms	INTRINSIC REFERENCES AND EXTRINSIC EVIDENCE*
1. "gesture"	Intrinsic Evidence **'978 Patent,** 33:57-60 at SYNAP 0000048 ("Touch sensor pointing devices can offer 'gestures,' which are special finger motions that simulate mouse button actions without the need for physical switches."), 33:62-65 at SYNAP 0000048 ("In the following discussion, the word 'finger' should be interpreted as including a stylus or other conductive object as previously described."), 8:38-40 at SYNAP 0000035 ("FIGS. 15A through 15G are timing diagrams illustrating some of the gestures that may be recognized according to the present invention."), 5:21-36, 7:39-49, 27:35-40, 31:38-44, 33:42-53, 34:57-40:58, 42:44-48, 42:50-46:45 at SYNAP 0000034, 0000035, 0000045, 0000047, 0000048-51, 0000052-54 (discussing the Tap, Drag, Locking Drag, Drag Extension, Double Tap, and Hop gestures illustrated in Figures 15A through 15G), 4:50-52, 8:48-49, 34:7-8, 41:42-48, 50:3-53 at SYNAP 0000033, 0000035, 0000048, 0000052, 0000056 (discussing a Push gesture), 34:7-8, 40:35-39, 46:46-50:2 at SYNAP 0000048, 0000051, 0000054-56 (discussing a Zig-Zag gesture), 53:1-16 at SYNAP 0000058 (discussing joystick and musical keyboard gestures), 34:27-30 at SYNAP 0000048 ("The system of FIG. 14 could clearly be extended to support other gestures than those described here, or to support fewer gestures in the interest of simplicity."); U.S. Pat. App. 10/810879 Dec. 7, 2005 Amendment After Final Rejection Pursuant to 37 C.F.R. § 1.116, at SYNAP 00000142 ("In particular, each of the claims recite that the user indicates a desired gesture (e.g. tapping, scrolling, dragging, etc.) by placing two objects (e.g. fingers) on or near the touch pad."). Extrinsic Evidence Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
2. "capacitance profile(s)"	Intrinsic Evidence **'978 Patent,** 7:3-5, 12:29-31 at SYNAP 0000035 and 0000037 ("the capacitive information from the sensing process provides a profile of the proximity of the finger to the sensor in each dimension."), 7:18-20 at SYNAP 0000035 (more detailed profile information is available and can be used "to discern simple multi-finger gestures to allow for a more powerful user interface"), 6:43-7:5 at SYNAP 0000034-35 ("complete set" language only used for one of two examples of embodiments), 7:6-12 at SYNAP 0000035 (information can be analog or digital), 9:44-58 at SYNAP 0000036 (detail about one example of a capacitance profile provided for a preferred embodiment). Extrinsic Evidence: U.S. Patent No. 5,825,352, 5:44-55, 7:34-40, at SYNAP 0001190 and 0001191 (using the analogous term "finger profile" to refer to the same type of capacitive information on conductive lines, even though the lines may be scanned sequentially or concurrently.); Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
3. "developing capacitance profiles" "develop a first capacitance profile" "develop at least one capacitance profile" "develop a second capacitive profile"	Intrinsic Evidence **'978 Patent,** 9:47-53 at SYNAP 0000036 (disclosing a preferred embodiment of "[t]he capacitance of a plurality of conductive lines running in a first direction (e.g., "X") is sensed by X input processing circuitry 12 and the capacitance of a plurality of conductive lines running in a second direction (e.g., "Y") is sensed by Y input processing circuitry 14. The sensed capacitance values are digitized in both X input processing circuitry 12 and Y input processing circuitry 14."), 9:16-20 at SYNAP 0000036 (not all embodiments limited to perform simultaneous measurement of traces), 6:43-48, 15:57-60 at SYNAP 0000034 and 0000039 (sensing of traces in parallel is disclosed in one embodiment as the solution to a common-mode noise problem completely unrelated to the claims), 6:49-7:5 at SYNAP 0000034-35 ("There are two drive/sense methods employed in the touch sensing technology of the present invention. According to a first and presently preferred embodiment of the invention, the voltages on all of the X lines of the sensor matrix are simultaneously moved, while the voltages of the Y lines are held at a constant voltage, with the complete set of sampled points simultaneously giving a profile of the finger in the X dimension. Next, the voltages on all of the Y lines of the sensor matrix are simultaneously moved, while the voltages of the X lines are held at a constant voltage to obtain a complete set of sampled points simultaneously giving a profile of the finger in the other dimension. According to a second

EXHIBIT C: SYNAPTICS' IDENTIFICATION OF REFERENCES/EVIDENCE

	drive/sense method, the voltages on all of the X lines of the sensor matrix are simultaneously moved in a positive direction, while the voltages of the Y lines are moved in a negative direction. Next, the voltages on all of the X lines of the sensor matrix are simultaneously moved in a negative direction, while the voltages of the Y lines are moved in a positive direction. This technique doubles the effect of any transcapacitance between the two dimensions, or conversely, halves the effect of any parasitic capacitance to ground. In both methods, the capacitive information from the sensing process provides a profile of the proximity of the finger to the sensor in each dimension."). Extrinsic Evidence Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
4. "identifying a simultaneous presence of at least two user input objects"	Intrinsic Evidence **'978 Patent**, 33:62-65 at SYNAP 0000048 (demonstrating that finger, object, and stylus are used interchangeably to refer to a sensed object), 33:62-65 at SYNAP 0000048 (user input object need not be a finger), 48:37-39 at SYNAP 0000055 ("When a second finger comes down on the pad, the (X, Y, Z) values typically take two or three samples to converge to their new values which reflect the presence of two fingers."), 46:52-53 at SYNAP 0000054 ("When two fingers are on the pad, the apparent position reported is midway between the two fingers."), 7:17-20 at SYNAP 0000035 ("However, unlike prior art, because the entire pad is being profiled, enough information is available to discern simple multi-finger gestures to allow for a more powerful user interface."), 53:1-16 at SYNAP 0000058 (disclosing detection of multiple touching points in a joystick or musical keyboard mode), 40:36-37 at SYNAP 0000051 (the "hop" gesture "never involves more than one finger on the pad at any one time"); Abstract at SYNAP 0000001 ("an application of at least two objects on the capacitive touch sensor pad"). Extrinsic Evidence U.S. Patent No. 5,825,352, 13:19-20, 13:4-12, 13:23-31, 13:32-44, 13:44-58, at SYN 0001194 (using the term "simultaneous presence" to encompass gestures other than a "second-finger tap"); Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
5. "examining said capacitance profiles to determine an occurrence of a single gesture" "examine said first capacitance profile to determine an occurrence of a single gesture" "examine at least one capacitance profile to determine an occurrence of a single gesture"	Intrinsic Evidence **'978 Patent**, 7:43-46 at SYNAP 0000035 ("According to a further object of the present invention, a number of gestures made by a finger or other object on the touch-sensor pad are recognized and communicated to a host."), 47:3-9 at SYNAP 0000055 ("It is possible to recognize second-finger taps using only the (X,Y,Z) information from the standard arithmetic unit 16, as described herein. However, it is clear that the arithmetic unit 16 could be modified to produce additional information, such as the width or shape of the sensor trace profile, which would aid in the accurate recognition of this gesture."); U.S. Pat. App. 10/810879 Dec. 7, 2005 Amendment After Final Rejection Pursuant to 37 C.F.R. § 1.116, at SYNAP 0000142 ("In particular, each of the claims recite that the user indicates a desired gesture (e.g. tapping, scrolling, dragging, etc.) by placing two objects (e.g. fingers) on or near the touch pad. The single gesture is recognized through examination of capacitance profiles developed across a matrix of conductors included within the sensor pad to identify the simultaneous presence of two fingers or other objects."). Extrinsic Evidence Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
6. "single gesture resulting from the	Intrinsic Evidence **'978 Patent**, 53:48-49; 54:4-5; 54:36-37 at SYNAP 0000058 (contemplating more than two fingers, saying, "at least two [user] input

EXHIBIT C: SYNAPTICS' IDENTIFICATION OF REFERENCES/EVIDENCE

simultaneous presence of the at least two user input objects" "single gesture resulting from the simultaneous proximity of at least two user input objects" "single gesture resulting from the simultaneous proximity of at least two input objects"	objects."); U.S. Pat. App. 10/810879 Dec. 7, 2005 Amendment After Final Rejection Pursuant to 37 C.F.R. § 1.116, at SYNAP 0000143 ("multiple simultaneous user inputs present on a touch pad sensor."). Extrinsic Evidence Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
7. "indicating the occurrence of said single gesture" "indicate the occurrence of said single gesture"	Intrinsic Evidence **'978 Patent**, 22:37-41, 28:3-29, 33:54-65, 34:65-35:8, 35:26-41, 43:15-62, 46:57-47:2, 49:45-55, 51:63-52:5 at SYNAP 0000042, 0000045, 0000048-49, 0000053, 0000054-55, 0000056, 0000057 (indicating information to a host can be done in a variety of ways, including with the use of packets of data similar or identical to those previously known in the art). Extrinsic Evidence Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
8. "signal representing a simulated mouse button click" "signal representing a simulated mouse action" "simulated mouse action"	Intrinsic Evidence **'978 Patent**, 33:66-34:3 at SYNAP 0000048 ("[r]eferring back to FIG. 1, according to another aspect of the present invention, gesture unit 20 examines the (X,Y,Z) data produced by arithmetic unit 16 to produce one or more "virtual mouse button" signals to be sent along with the (ΔX, ΔY) signals to the host."), 34:4-8 at SYNAP 0000048 (Gesture unit 20 processes single-finger taps, corner taps, double taps, scroll motions, drags, and pushes, all of which do not require a "second-finger tap" yet produce simulated mouse actions.), 35:57-62, 45:5-9 at SYNAP 0000049 and 0000054(disclosing embodiments where variables are set to values other than LEFT or RIGHT), 41:28-36 at SYNAP 0000052 ("FIGS. 17A through 17F comprise a flowchart for the operation of tap unit 280. Tap unit 280 implements the tap, drag, locking drag, drag extension, corner-tap, and hop gestures described herein. In the gesture recognition operations described herein, the cornertap is used to simulate the right virtual mouse button. Hops to the left and right are used to simulate the middle and right virtual mouse buttons. Simple taps simulate the left (primary) virtual mouse button."), 34:21-56 at SYNAP 0000048 ("Tap unit 280, zigzag unit 282, and push unit 284 examine the sequence of (X,Y,Z) samples to look for various types of gestures. The outputs of all these units, plus the switch signals, are combined in button control unit 286 to produce the actual button-press signals sent to the host. In the illustrative example disclosed herein, the touchpad simulates a three-button (Left, Middle, Right) pointing device. The system of FIG. 14 could clearly be extended to support other gestures than those described here, or to support fewer gestures in the interest of simplicity. Button control unit 286 can use any of several well-known methods for combining multiple signals. For example, a priority ordering can be established among the various sources, or each button output (Left, Middle, and Right) can be asserted ("clicked", "pressed" or "held down") whenever any of the sources indicate that button. Any

EXHIBIT C: SYNAPTICS' IDENTIFICATION OF REFERENCES/EVIDENCE

	particular method of combining these signals is a routine design detail dependent on a particular system configuration, which may be easily implemented by persons of ordinary skill in the art. In a presently preferred embodiment, the button control unit 286 maps both switches and gestures to the most commonly used virtual buttons, giving maximum flexibility to the user. In an alternate embodiment, switches and gestures can be mapped to different virtual buttons so that a larger number of virtual buttons can be covered without resort to exotic gestures. Or, the user can be offered a choice of mappings. It is well known in the art to allow extra button switches to be processed as specialized commands, such as double-clicking, selecting commonly used menu items, etc., instead of their normal role as mouse buttons. Similarly, the button control unit 286 or host software could map some of the gestures described here to software commands instead of simulating mouse buttons. Such processing and mapping is well within the realm of ordinary skill in the art."), Figs. 15A-15G, 33:50-65, 34:21-56 at SYNAP 0000017-19 and 0000048 (disclosing simulated mouse actions and simulated mouse button clicks unrelated to a second finger tap), Fig 17C, 34:27, 35:47-62 at SYNAP 0000023, 0000048, and 0000049 (disclosing numerous gestures that generate simulated mouse button clicks, including a middle button), 35:26-41, 51:63-52:5 at SYNAP 0000049 and 0000057 (disclosing simulated mouse actions, such as cursor motion, unrelated to the values LEFT or RIGHT or to a second button click). <u>Extrinsic Evidence</u> April 6, 2007 Claim Construction Order, *Elantech Devices Corp. v. Synaptics, Inc. et al*, Case No. 3:06-cv-01839-CRB [Docket No. 91], at 8:13-14, ("[t]he word 'signal' is used broadly throughout the '931 patent," another Synaptics patent with a nearly identical specification); Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
9. "developing capacitance profiles in both said X and Y directions"	<u>Intrinsic Evidence</u> **'978 Patent**, see above (3). <u>Extrinsic Evidence</u> Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
10. "capacitive sensor"	<u>Intrinsic Evidence</u> **'978 Patent**, 7:53-67, 9:26-29, 9:44-58 at SYNAP 0000035 and 0000036 (disclosing a device with a plurality of conductive lines that senses capacitive information), 10:7-25 at SYNAP 0000036 (demonstrating such a sensor can be constructed from a variety of materials in a variety of ways). <u>Extrinsic Evidence</u> Modern Dictionary of Electronics (1999), at SYNAP 0001449 and 0001451 ("capacitance sensor" means "A sensor that responds to a change in capacitance in a field containing a protected object or in a field with a protected area."; "sensor" means "Any device that can detect the presence of, or a change in the level of …capacitance"); Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
11. "sensing circuitry"	<u>Extrinsic Evidence</u> The IEEE Standard Dictionary of Electrical and Electronics Terms (Sixth Edition), at SYNAP 0001444-45 ("circuit" means "An interconnection of electrical elements."; "sensing circuit" means "a circuit whose function is to detect the occurrence of some event at its input terminals"); Modern Dictionary of Electronics (1999), at SYNAP 0001451 ("sensing" means "the process of determining the sense of an indication".); Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
12. "configured to generate outputs based on the capacitance"	<u>Intrinsic Evidence</u> **'978 Patent**, 13:29-40 at SYNAP 0000038. <u>Extrinsic Evidence</u>

EXHIBIT C: SYNAPTICS' IDENTIFICATION OF REFERENCES/EVIDENCE

	The Modern Dictionary of Electronics (1999), at SYNAP 0001450 ("output" means "the transfer of information from an information process".); Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
13. "button press"	Extrinsic Evidence Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.
14. "simultaneous presence" "simultaneous proximity"	Intrinsic Evidence **'978 Patent**, 53:48-49; 54:4-5; 54:36-37 at SYNAP 0000058 (contemplating more than two fingers, saying, "at least two [user] input objects."); U.S. Pat. App. 10/810879 Dec. 7, 2005 Amendment After Final Rejection Pursuant to 37 C.F.R. § 1.116, at SYNAP 0000143 ("multiple simultaneous user inputs present on a touch pad sensor."). Extrinsic Evidence Opinions and Rebuttal Opinions of Dr. Andrew Wolfe.

* The references and evidence cited below for each claim term may be used in connection with other related claim terms and will not be reiterated in each of the separate claim terms to which it may be relevant. For example, the term "capacitance profile(s)" is used in many claim limitations beginning with Claim Term 3. Synaptics will not necessarily repeat the references and evidence for such repeated or interrelated terms but, instead, hereby incorporates the references and evidence into each subsequent claim term.

EXHIBIT H

SEVENTH EDITION

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Library of Congress Cataloging-in-Publication Data

Graf, Rudolf F.
Modern dictionary of electronics / Rudolf F. Graf.—7th ed., revised and updated.
p. cm.
ISBN 0-7506-9866-7 (alk. paper)
1. Electronics—Dictionaries. I. Title
TK7804.G67 1999
621.381'03—dc21 99-17889
CIP

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

The publisher offers special discounts on bulk orders of this book.
For information, please contact:
Manager of Special Sales
Butterworth-Heinemann
225 Wildwood Avenue
Woburn, MA 01801-2041
Tel: 781-904-2500
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10 9 8 7 6 5 4 3 2 1

Typeset by Laser Words, Madras, India
Printed in the United States of America

capacitance level detector — A device with single or multiple probes that operates based on the fact that a change in capacitance level causes a change in probe capacitance.

capacitance meter — An instrument for measuring capacitance. If the scale is graduated in microfarads, the instrument is usually designated a microfaradmeter.

capacitance-operated intrusion detector — A boundary alarm system in which the approach of an intruder to an antenna wire encircling the protected area (a few feet above ground) changes the antenna-to-ground capacitance and thereby sets off the alarm.

capacitance ratio — The ratio of maximum to minimum capacitance, as determined from a capacitance characteristic, over a specified voltage range.

capacitance relay — An electronic circuit incorporating a relay that responds to a small change in capacitance, such as that created by bringing the hand or body near a pickup wire or plate.

capacitance sensor — A sensor that responds to a change in capacitance in a field containing a protected object or in a field within a protected area. Also called capacitance detector.

capacitance switch — A keyboard switch in which two pads on the circuit board under each keyswitch serve as capacitor plates connected to the drive and sense circuits. Depression of the key causes an increase in the series capacitance, coupling the two elements and creating an analog signal in the sense circuit.

capacitance tolerance — The maximum percentage deviation from the specified nominal value (at standard or stated environmental conditions) specified by the manufacturer.

capacitive coupling — Also called electrostatic coupling. The association of two or more circuits with one another by means of mutual capacitance between them. For example, between stages of an amplifier, that type of interconnection that employs a capacitor in the circuit, between the plate of one tube and the grid of the following tube or the collector of one transistor and the base of the following transistor.

capacitive diaphragm — A resonant window placed in a waveguide to provide the effect of capacitive reactance at the frequency being transmitted.

capacitive-discharge ignition — Also called capacitor-discharge ignition. An electronic ignition system used on internal combustion engines to provide nearly constant high voltage regardless of engine speed. A dc-to-dc step-up converter charges a capacitor when the distributor breaker points are closed; when they are open, the capacitor discharges through the ignition coil, thereby generating the ignition voltage

capacitive divider — Two or more capacitors placed in series across a source, making available a portion of the source voltage across each capacitor. The voltage across each capacitor will be inversely proportional to its capacitance.

capacitive feedback — The process of returning part of the energy in the plate or output circuit of a vacuum tube to the grid, or input, circuit by means of a capacitance common to both circuits.

capacitive load — A predominantly capacitive load, that is, one in which the current leads the voltage.

capacitive post — A metal post or screw extending at right angles to the E field in a waveguide. It provides capacitive susceptance in parallel with the waveguide for purposes of tuning or matching.

capacitive reactance — Symbolized by X_C. The impedance a capacitor offers to ac or pulsating dc. Measured in ohms and equal to $1/2\pi f C$, where f is in hertz and C is in farads.

capacitive speaker — *See* electrostatic speaker.

capacitive storage welding — A particular type of resistance welding whereby the energy is stored in banks of capacitors, which are then discharged through the primary of the welding transformer. The secondary current generates enough heat to produce the weld.

capacitive transduction — Conversion of the measurand into a change in capacitance.

capacitive tuning — Tuning by means of a variable capacitor.

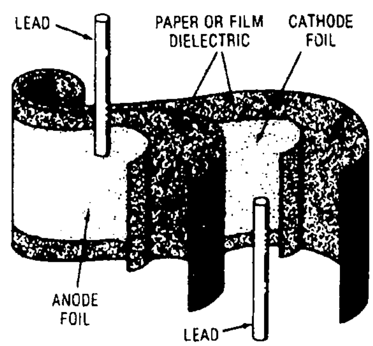
capacitive voltage divider — A combination of capacitors connected in series to form a capacitive voltage dividing device for application with ac voltages.

capacitive welding — An electronic welding system in which energy stored in a capacitor is discharged through the joint to be welded. The resulting current develops the heat necessary for the operation.

capacitive window — A conductive diaphragm extended into a waveguide from one or both sidewalls to introduce the effect of capacitive susceptance in parallel with the waveguide.

capacitivity — *See* dielectric constant.

capacitor — 1. A device consisting essentially of two conducting surfaces separated by an insulating material or dielectric such as air, paper, mica, glass, plastic film, or oil. A capacitor stores electrical energy, blocks the flow of direct current, and permits the flow of alternating current to a degree dependent essentially on the capacitance and the frequency. 2. An electrical energy storage device used in the electronics industry for varied applications, notably as elements of resonant circuits, in coupling and bypass application, blockage of dc current, as frequency determining and timing elements, as filters and delay-line components, and in voltage transient suppression.



Capacitor (internal construction).

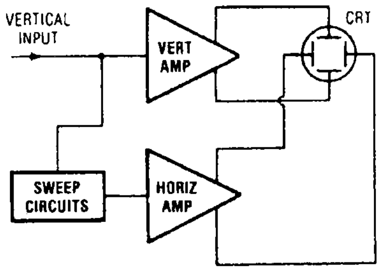
capacitor antenna — Also called condenser antenna. An antenna that consists of two conductors or systems of conductors and the essential characteristic of which is its capacitance.

capacitor bank — A number of capacitors connected together in series, parallel, or in series-parallel.

capacitor braking — A means of stopping an induction motor. The capacitor or capacitors can be applied to the winding after shut-off.

capacitor color code — Color dots or bands placed on capacitors to indicate one or more of the following: capacitance, capacitance tolerance, voltage rating, temperature coefficient, and the outside foil (on paper or film capacitors).

capacitor-discharge ignition — *See* capacitive-discharge ignition.



Oscilloscope.

of the instrument, the vertical deflection is a signal voltage and the horizontal deflection is a linear time base. 2. A cathode-ray tube with attendant amplifiers and control circuits for measuring and studying the waveforms of small currents and voltages. A CRT oscilloscope is particularly convenient for studying repetitive phenomena, but a tube with a long-delay phosphor can be used to analyze a single electrical pulse. An oscilloscope equipped with a camera (often of the instant type) becomes an oscillograph. 3. An electronic window that displays variations of voltage at any point in a circuit by displaying in graphic form on its screen the actual waveform of voltage plotted against time. In addition, an oscilloscope serves as an accurate ac/dc voltmeter and time-period counter. The typical scope is made up of five major interrelated parts: vertical amplifier section, horizontal amplifier section, sweep and synchronization circuits, picture tube (cathode-ray tube or CRT), and power supply. The electron beam strikes the fluorescent screen of the cathode-ray tube and temporarily produces a visible pattern or waveform of some fluctuating electrical quantity such as voltage. The pattern is employed to reveal the detailed variations in rapidly changing electric currents, potentials, or pulses.

oscilloscope differential amplifier—A device that amplifies and displays the voltage difference that exists at every instant between signals applied to its two inputs.

oscilloscope tube—Also called oscillograph tube. A cathode-ray tube that produces a visible pattern that is the graphical representation of electric signals. The pattern is seen as a spot or spots, which change position in accordance with the signals.

OSHA—Acronym for Occupational Safety and Health Act. A federal law that specifies the requirements an employer must follow in order to guard against employee illness and injury.

OSI—Abbreviation for Open Systems Interconnection. A layered architecture designed to permit interconnection between heterogeneous computer systems. Also, the international protocol for communications in a multiple-vendor environment.

OSO—Abbreviation for Orbiting Solar Observatory.

O-type backward-wave oscillator—A wideband, voltage-tunable microwave oscillator that uses a fundamental or space harmonic with phase and group velocity of different signs.

outage—1. Loss of signal in a channel, usually the result of a dropout or a hit. 2. Status of equipment when it is out of service. Outages are termed *forced* when due to undesired occurrences, and *planned* when prescheduled, as for routine maintenance.

outconnector—In a flowchart, a connector indicating a point at which a flowline is broken to be continued at another point.

outdoor antenna—A receiving antenna located on an elevated site outside a building.

outdoor transformer—A transformer of weatherproof construction.

outer marker—In an instrument landing system, a marker located on a localizer course line at a recommended distance (normally about 4½ miles or 7.2 km) from the approach end of the runway.

outgas—The release of gas from a material over a period.

outgassing—1. A phenomenon in which a substance in a vacuum spontaneously releases absorbed and occluded constituents as vapors or gases. 2. De-aeration or other gaseous emission from a printed board assembly (printed board, component, or connector) when exposed to a reduced pressure or heat, or both.

outlet—1. The point where current is taken from a wiring system. 2. Convenience receptacle used for supplying power in the home, shop, or laboratory from power-company mains. 3. A point on the wiring system that can be tapped to provide electrical current for appliances or lights.

outlet box—Metal box that houses a switch or receptacle.

outline drawing—A drawing showing approximately overall shape, but no detail.

out of phase—1. Two or more waveforms that have the same shape, but do not pass through corresponding values at the same instant. 2. Relationship between periodic waves of the same frequency, but which do not pass through their maximum and minimum (or other corresponding) values at the same instant.

out-of-service jack—A jack, associated with a test jack, into which a shorted plug may be inserted to remove a circuit from service.

outphaser—In electronic organs, a circuit that changes a sawtooth wave to something approaching a square wave by adding to the sawtooth a second sawtooth of twice the frequency and half the amplitude in reverse phase, thus canceling the even harmonics.

outphasing—In electronic organs, a term applied to a method sometimes used for producing certain voices. Special circuitry, placed between the keying-system output and the formant filters, either adds or subtracts harmonics or subharmonics of the tone-generator signal.

output—1. The current, voltage, power, or driving force delivered by a circuit or device. 2. The terminals or other places where the circuit or device may deliver the current, voltage, power, or driving force. 3. Information transferred from the internal to the secondary or external storage of a computer. 4. The electrical quantity produced by a transducer, which is a function of the measurand. 5. The useful energy delivered by a circuit or device. 6. In logic circuits, frequently used to mean a change in condition between conducting and nonconducting. (It is like calling the coil of a relay the input and the contacts the output.) 7. The signal level at the output of an amplifier or other device. 8. A port or set of terminals at which a system or component delivers useful energy or a useful signal. Also the energy or signal delivered. The useful signal delivered by a recorder using a particular type of tape, usually at an arbitrarily fixed level of harmonic distortion (1 or 3 percent) and relative to the performance of a tape with standard characteristics. 9. The transfer of information from an information process. 10. The act of providing information from a device to the outside world. Generally accompanied by a device that inputs the information being output by the first device.

output amplifier—A circuit that energizes high-power-level devices upon application of a low-power-level input signal.

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sending-end impedance — Also called the driving-point impedance. The ratio of an applied potential difference of a transmission line to the resultant current at the point where the potential difference is applied.

sending filter — A filter used at the transmitting terminal to restrict the transmitted frequency band.

sensation level — *See* level above threshold.

sense — 1. In navigation, the relationship between the change in indication of a radionavigational facility and the change in the navigational parameter being indicated. 2. In some navigational equipment, the property of permitting the resolution of 180° ambiguities. 3. To examine or determine the status of some system components. 4. To read holes in punched tape or cards.

sense amplifier — 1. A circuit used to sense low-level voltages such as those produced by magnetic or plated-wire memories and to amplify these signals to the logic voltage levels of the system. 2. A circuit used in communications-electronics equipment to determine a change of phase or voltage and to provide an automatic control function.

sense finder — In a direction finder, that portion which permits determination of direction without 180° ambiguity.

sense-reversing reflectivity — The characteristic of a reflector that reverses the sense of an incident ray. (For example, a perfect corner reflector is invisible to a circularly polarized radar because it reverses the sense.)

sense step — *See* secondary calibration.

sense switch — One of a series of switches on the console of the digital computer that permits the operator to control some parts of a program externally.

sense wire — A wire threaded through the core of a magnetic memory to detect whether a logical 1 or 0 is stored in the core when the core is interrogated by a read pulse. This technology is no longer in use.

sensing — 1. The process of determining the sense of an indication. 2. A technique used in a power supply regulator for monitoring the output voltage or current. In local sensing, the monitor points are the output terminals. In remote sensing, the monitor points are located at appropriate locations in the circuit being powered, connected by wire to sensing input terminals on the supply.

sensing element — *See* primary detector.

sensing field — The zone in which an object can be sensed by a proximity switch.

sensistor — A silicon resistor whose resistance varies with temperature, power, and time.

sensitive relay — 1. A relay requiring only a small current. It is used extensively in photoelectric circuits. 2. Any of a number of different types of relays requiring very low pickup power. Generally considered to be one requiring less than 100 milliwatts of pickup power.

sensitive volume — In a radiation-counter tube, the portion responding to a specific radiation.

sensitivity — 1. The minimum input signal required in a radio receiver or similar device to produce a specified output signal having a specified signal-to-noise ratio. This signal input may be expressed as power or voltage at a stipulated input network impedance. 2. Ratio of the response of a measuring device to the magnitude of the measured quantity. It may be expressed directly in divisions per volt, milliradians per microampere, etc., or indirectly by stating a property from which sensitivity can be computed (e.g., ohms per volt for a stated deflection). 3. The signal current developed in a camera tube per unit incident radiation density (i.e., per watt per unit area). Unless otherwise specified, the radiation is understood to be that of unfiltered incandescent source of 2854 K, and its density, which is generally measured in watts per unit area, may then be expressed in lumens per foot. 4. The degree of response of an instrument or control unit to a change in the incoming signal. 5. In tape recording, the relative intensity of the magnetic signal recorded by a magnetizing field of a given intensity. 6. A measurement of the electrical output of a microphone for a given sound pressure level at its diaphragm. 7. The smallest input change that a DMM is able to display. It is equal to the least significant digit on the lowest measurement range. For example, a three-digit DMM with a 100-mV range has 100 μV sensitivity. 8. Generally expressed in dBm at a specified impedance (usually 600 ohms), sensitivity is a measure of the lowest DTMF signal level that a receiver can detect. It represents an absolute threshold below which detection of a single frequency is not generated. 9. Measure of the ability of a device or circuit to react to a change in some input. 10. In television, a factor expressing the incident illumination on a specified scene required to produce a specified picture signal at the output terminals of a television camera. 11. A measure of relative output for a given input of a tape, microphone, etc. 12. Characteristic of a receiver that determines the minimum input signal strength required for a given signal output. Sensitivity is usually measured in microvolts (μV).

sensitivity adjustment — Also called span adjustment. The control of the ratio of output signal to excitation voltage per unit measurand. Generally accomplished in a system by changing the gain of one or more amplifiers. The practice of placing excitation control components (such as potentiometers or rheostats) in series with the excitation to a transducer is a sensitivity adjustment for the system. However, in the latter case no significant change is introduced in the output-to-input ratio of the transducer.

sensitivity control — The control that adjusts the amplification of the radio-frequency amplifier stages and thereby makes the receiver more sensitive.

sensitivity-time control — Also called gain-time control or time gain. The portion of a system that varies the amplification of a radio receiver in a predetermined manner.

sensitizing (electrostatography) — The establishing of an electrostatic surface charge of uniform density on an insulating medium.

sensitometer — An instrument used to measure the sensitivity of light-sensitive materials.

sensitometry — Measurement of the light-response characteristics of photographic film.

sensor — 1. In a navigational system, the portion that perceives deviations from a reference and converts them into signals. 2. A component that converts mechanical energy into an electrical signal, either by generating the signal or by controlling an external electrical source. 3. *See* primary detector. 4. An information-pickup device. 5. A transducer designed to produce an electrical output proportional to some time-varying quantity, as temperature, illumination, pressure, etc. 6. The component of an instrument that converts an input signal into a quantity that is measured by another part of the instrument. 7. Any device that can detect the presence of, or a change in the level of, light, sound, capacitance, magnetic field, etc. 8. A device or component that reacts to a change; the reaction is then used to cause a control or instrument to function. For example, a thermistor changes resistance as temperature changes, and the resistance changes can be used in an electric circuit to vary current. 9. A transducer that converts a parameter at a test point to a form suitable for measurement by the test equipment. 10. A sensing element. The basic element of a transducer that usually changes some physical parameter to an electrical

signal. 11. A device that is designed to produce a signal or offer indication in response to an event or stimulus within its detection zone. 12. A component that provides an electrical signal in response to a specific physical or chemical stimulus such as heat, pressure, magnetic field, or a particular chemical vapor. Microsensors are fabricated using processes similar to those for manufacturing ICs, or extensions of such processes. Integrated microsensors incorporate an integrated circuit on the same die as that used for the sensor element.

sensory robot — A computerized robot with one or more artificial senses, usually sight or touch.

sentinel — 1. A symbol marking the beginning or end of some piece of information in digital-computer programming. 2. *See* tag.

separate excitation — Excitation in which generator field current is provided by an independent source, or motor field current is provided from a source other than the one connected across the armature.

separately instructed carry — Executing the carry process in a computer by allowing carry information to propagate to succeeding places only when a specific signal is received.

separation — The degree to which two stereo signals are kept apart. Stereo realism is dependent on the successful prevention of their mixture before reaching the output terminals of the power amplifier. Tape systems have a separation capability inherently far superior to that of the disc systems.

separation circuit — A circuit that separates signals according to their amplitude, frequency, or some other selected characteristic.

separation filter — A combination of filters used to separate one band of frequencies from another — often, to separate carrier and voice frequencies for transmission over individual paths.

separation loss — The loss that occurs in output when the surface coating of a tape fails to make perfect contact with the surfaces of either the record or reproduce head.

separator — 1. An insulating sheet or other device employed in a storage battery to prevent metallic contact between plates of opposite polarity within a cell. 2. An insulator used in the construction of convolutely wound capacitors. 3. *See* delimiter.

septate coaxial cavity — A coaxial cavity with a vane or septum added between the inner and outer conductors. The result is a cavity that acts as if it had a rectangular cross section bent transversely.

septate waveguide — A waveguide with one or more septa placed across it to control microwave power transmission.

septum — A thin metal vane that has been perforated with an appropriate wave pattern. It is inserted into a waveguide to reflect the wave. Plural: septa.

sequence — 1. The order in which objects or items are arranged. 2. To place in order. 3. A succession of terms so related that each may be derived from one or more of the preceding terms in accordance with some fixed law.

sequence checking routine — A checking routine that examines every instruction executed and prints certain data concerning this check.

sequence control — Automatic control of a series of operations in a predetermined order.

sequencer — 1. The component of a processor that controls the program flow by implementing branches for subroutine processing and handling interrupts. 2. A device or computer program that records, edits, and plays back MIDI data much like a word processor for music, such that you can fix wrong notes or lengthen or shorten notes. 3. A mechanical or electronic device that may be set to initiate a series of events and to make the events follow in sequence. 4. A circuit that pulls information from the control store memory, based on external conditions. 5. In a bit-slice system, the module in charge of providing the next microprogram address to the microprogram memory. Essentially a complex multiplexer, but may include stack facilities and a loop counter.

sequence relay — A relay that controls two or more sets of contacts in a predetermined sequence.

sequencer register — In a computer, a counter that is pulsed or reset following the execution of an instruction to form the new memory address that locates the next instruction.

sequence timer — A succession of time-delay circuits arranged so that completion of the delay in one circuit initiates the delay in the following circuit.

sequencing equipment — A special selecting device by means of which messages received from several teletypewriter circuits may be subsequently selected and retransmitted over a smaller number of trunks or circuit.

sequency of operation — A detailed written description of the order in which electrical devices and other parts of the equipment should function.

sequential access — 1. An access mode in which records are retrieved in the same order in which they were written. Each successive access to a file refers to the next record in the file. 2. A term used to describe files such as magnetic tape that must be searched sequentially to find any desired record. 3. Computer access method in which a word is accessed by scanning sequential blocks or records. For example: a tape. 4. Data on storage, such as magnetic tape, that much be searched serially from the beginning to find any desired record.

sequential-access file — A type of file structure in which data may only be accessed sequentially, one record at a time. Data stored on magnetic tape is an example of a sequential file.

sequential-access memory — Abbreviated SAM. 1. A serial-type memory in which words are selected in a fixed order. The addressing circuit steps from word to word in a predetermined order, with the result that the access time for the stored information (words) is variable. 2. A method of information retrieval in which the complete memory is scanned and each word is, in its turn, read out, worked on, then rewritten.

sequential circuit — A digital circuit that changes state according to an input signal (normally under clock control); it must be tested with a sequence of signals.

sequential color television — A color television system in which the three primary colors are transmitted in succession and reproduced on the receiver screen in the same manner.

sequential color transmission — The transmission of television signals that originate from variously colored parts of an image in a particular sequential order.

sequential computer — A computer in which events occur in time sequence with little or no simultaneous occurrence or overlap of events.

sequential control — Digital-computer operation in which the instructions are set up in sequence and fed to the computer consecutively during the solution of a problem.

sequential element — A device having at least one output channel and one or more input channels, all characterized by discrete states, such that the state of each output channel is determined by the previous states of the input channels.

sequential interlace — A method of interlacing in which the lines of one field are placed directly under the corresponding lines of the preceding field.

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IEEE Std 100-1996

The IEEE Standard Dictionary of Electrical and Electronics Terms

Sixth Edition

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The IEEE Standard Dictionary of Electrical and Electronics Terms

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Jane Radatz, Chair

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ISBN 1-55937-833-6
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does not affect the sign position. For example, +231.702 shifted two places to the left becomes +170.200. *Note:* The result is equivalent to multiplication or division by an integral power of the radix, except for the truncation effects. *Synonym:* numerical shift. *Contrast:* logical shift. (C) 1084-1986w

(2) (general) (A) A shift that does not affect the sign position. **(B)** A shift that is equivalent to the multiplication of a number by a positive or negative integral power of the radix. (C/MIL) [2], [85]

arithmetic underflow *See:* underflow.

arithmetic unit (1) The unit of a computing system that contains the circuits that perform arithmetic operations. (C/MIL) [2], [20], [85]

(2) A functional component of a computer system that performs arithmetic operations. *Note:* The term is also sometimes used for an arithmetic and logic unit. *Synonym:* arithmetic element. *See also:* scalar unit; vector unit. (C) 610.10-1994

arm *See:* branch; network analysis.

arm a timer To start a timer measuring the passage of time, enabling the notification of a process when the specified time or time interval has passed. (C/PA) 1003.5b-1995

armature (of a relay) The moving element of an electromechanical relay that contributes to the designed response of the relay and that usually has associated with it a part of the relay contact assembly. (PE/SWG) C37.100-1992

armature band (rotating machinery) A thin circumferential structural member applied to the winding of a rotating armature to restrain and hold the coils so as to counteract the effect of centrifugal force during rotation. *Note:* Armature bands may serve the further purpose of archbinding the coils. They may be on the end windings only or may be over the coils within the core. (PE) [9]

armature band insulation (rotating machinery) An insulation member placed between a rotating armature winding and an armature band. *See also:* armature. (PE) [9]

armature bar (half coil) (rotating machinery) Either of two similar parts of an armature coil, comprising an embedded coil side and two end sections, that when connected together form a complete coil. *See also:* armature. (PE) [9]

armature coil (rotating machinery) A unit of the armature winding composed of one or more insulated conductors. *See also:* armature; asynchronous machine. (EEC/PE) [119]

armature core (rotating machinery) A core on or around which armature windings are placed. *See also:* armature. (PE) [9]

armature I^2R loss (synchronous machines) The sum of the I^2R losses in all of the armature current paths. *Note:* The I^2R loss in each current path shall be the product of its resistance in ohms, as measured with direct current and corrected to a specified temperature, and the square of its current in amperes. (PE/REM) [115], [9]

armature quill *See:* armature spider.

armature reaction (rotating machinery) The magnetomotive force due to armature-winding current. (PE) [9]

armature-reaction excited machine A machine having a rotatable armature, provided with windings and a commutator, whose load-circuit voltage is generated by flux that is produced primarily by the mag-netomotive force of currents in the armature winding. *Notes:* 1. By providing the stationary member of the machine with various types of windings, different characteristics may be obtained, such as a constant-current characteristic or a constant-voltage characteristic. 2. The machine is normally provided with two sets of brushes, displaced around the commutator from one another, so as to provide primary and secondary circuits through the armature. 3. The primary circuit carrying the excitation armature current may be completed externally by a short-circuit connection, or through some other external circuit, such as a field winding or a source of power supply; and the secondary circuit is adapted for connection to an external load. (EEC/PE) [119]

armature sleeve *See:* armature spider.

armature spider A support upon which the armature laminations are mounted and which in turn is mounted on the shaft. *Synonyms:* armature quill; armature sleeve. (EEC/PE) [119]

armature terminal (rotating machinery) A terminal connected to the armature winding. *See also:* armature. (PE) [9]

armature to field transfer function (G[s]) (synchronous machine parameters by standstill frequency testing) (standstill frequency response testing). The ratio of the Laplace transform of the direct-axis armature flux linkages to the Laplace transform of the field voltage, with the armature open-circuited. (PE) 115A-1987

armature-voltage control A method of controlling the speed of a motor by means of a change in the magnitude of the voltage impressed on its armature winding. *See also:* control. (IA) [60]

armature winding (rotating machinery) The winding in which alternating voltage is generated by virtue of relative motion with respect to a magnetic flux field. *See also:* asynchronous machine. (PE) [9]

armature winding cross connection *See:* armature winding equalizer.

armature winding equalizer (rotating machinery) An electric connection to normally equal-potential points in an armature circuit having more than two parallel circuits. *Synonym:* armature winding cross connection. *See also:* armature. (PE) [9]

armed sweep *See:* single sweep.

armor clamp (wiring methods) A fitting for gripping the armor of a cable at the point where the armor terminates or where the cable enters a junction box or other piece of apparatus. (PE/T&D) [10]

armored cable (interior wiring) A fabricated assembly of insulated conductors and a flexible metallic covering. *Note:* Armored cable for interior wiring has its flexible outer sheath or armor formed of metal strip, helically wound and with interlocking edges. Armored cable is usually circular in cross section but may be oval or flat and may have a thin lead sheath between the armor and the conductors to exclude moisture, oil, etc., where such protection is needed. *See also:* nonmetallic-sheathed cable. (EEC/PE) [119]

arm, thermoelectric The part of a thermoelectric device in which the electric-current density and temperature gradient are approximately parallel or antiparallel and that is electrically connected only at its extremities to a part having the opposite relation between the direction of the temperature gradient and the electric-current density. *Note:* The term thermoelement is ambiguously used to refer to either a thermoelectric arm or to a thermoelectric couple, and its use is therefore not recommended. *See also:* thermoelectric device. (ED) [46], 221-1962w

arm, thermoelectric, graded A thermoelectric arm whose composition changes continuously along the direction of the current density. *See also:* thermoelectric device. (ED) [46], 221-1962w

arm, thermoelectric, segmented A thermoelectric arm composed of two or more materials having different compositions. *See also:* thermoelectric device. (ED) [46], 221-1962w

ARQ *See:* automatic repeat request.

array (1) (photovoltaic converter) A combination of panels coordinated in structure and function. *See also:* semiconductor. (AE) [41]

(2) (solar cells) A combination of solar-cell panels or paddles coordinated in structure and function. (AE) 307-1969w

(3) (data management software) An *n*-dimensional ordered set of data items identified by a single name and one or more

chrominance subcarrier (color television) The carrier whose modulation sidebands are added to the luminance signal to convey color information. (BT) 201-1979w

chronaxie (medical electronics) The minimum duration of time required to stimulate with a current of twice the rheobase. (EMB) [47]

chronic exposure Exposure over a relatively long time. (PE/T&D) 539-1990

chronometer (navigation aids) A time piece with a nearly constant rate. Set approximately to Greenwich Mean Time. (AE) 172-1983w

chute *See:* feed tube.

CI *See:* configuration item.

CIE *See:* Commission Internationale de l'Eclairage.

CIE (L*a*b*) uniform color space (illuminating engineering) A transformation of CIE tristimulus values X, Y, Z into three coordinates that define a space in which equal distances are more nearly representative of equal magnitudes of perceived color difference. This space is specially useful in cases of colorant mixtures, for example, dye-stuffs, paints. (EEC/IE) [126]

CIE (L*u*v*) uniform color space (illuminating engineering) A transformation of CIE tristimulus values X, Y, Z into three coordinates that define a space in which equal distances are more nearly representative of equal magnitudes of perceived color difference. This space is specially useful in cases where colored lights are mixed additively for example, color television. (EEC/IE) [126]

CIE standard chromaticity diagram (illuminating engineering) One in which the *x* and *y* chromaticity coordinates are plotted in rectangular coordinates. *Note:* The diagram may be based on the CIE 1931 Standard Observer or on the CIE 1964 Supplementary Standard Observer. *See also:* color matching functions (spectral tristimulus values). (EEC/IE) [126]

CIE standard colorimetric observer, 1931 Receptor of radiation whose colorimetric characteristics correspond to the distribution coefficients $\bar{x}_\lambda$, $\bar{y}_\lambda$, $\bar{z}_\lambda$ adopted by the International Commission on Illumination in 1931. *See also:* color. (BT) [34], [84]

CIGRE *See:* Conférence Internationale Des Grands Réseaux Electriques.

CIM *See:* computer input microfilm; computer-integrated manufacturing.

CINEMA A hardware description language with a compiler written in BCPL; contains normal control statements and also statements providing parallel execution of program statements. (C) 610.13-1993

cine-oriented image In micrographics, an image appearing on a roll of microfilm in such a manner that the top edge of the image is perpendicular to the long edge of the film. *Synonyms:* motion picture display; portrait image. *Contrast:* comic-strip oriented image. (C) 610.2-1987

C interface The C language binding, defined in terms of ISO/IEC 9899: 1990. (C/PA) 1327-1993, 1328-1993

ciphertext Data produced through the use of encipherment, the semantic content of which is not available. *Note:* Ciphertext may itself be input to encipherment, producing superenciphered data. (C/LM) 802.10-1992

circadian rhythm Oscillation of biological processes with an approximate 24 h period regulated by external stimuli. (PE/T&D) 539-1990

circle diagram (A) (rotating machinery) Circular locus describing performance characteristics (current, impedance, etc.) of a machine or system. In case of rotating machinery, the term "circle diagram" has, in addition, some specific usages: The locus of the armature current phasor of an induction machine, or of some other type of asynchronous machine, displayed on the complex plane, with the shaft speed as the variable (parameter), when the machine operates at a constant voltage and at a constant frequency. **(B) (rotating machinery)** The locus of the current vector(s) of a nonsalient-pole synchronous machine, displayed in a synchronously rotating reference frame (Park transform, *d-q* coordinates), with the active component of the load, hence with the rotor displacement angle, as the variable (parameter), when the machine operates at a constant field current. **(C) (rotating machinery)** The locus of the current phasor(s) of (2) *See also:* asynchronous machine. (PE) [9]

circling guidance lights (illuminating engineering) Aeronautical ground lights provided to supply additional guidance during a circling approach when the circling guidance furnished by the approach and runway lights is inadequate. (EEC/IE) [126]

circuit (1) The physical medium on which signals are carried across the AUI. The data and control circuits consist of an A circuit and a B circuit forming a balanced transmission system so that the signal carried on the B circuit is the inverse of the signal carried on the A circuit. (C/LM) 8802-3-1990s
(2) A conductor or system of conductors through which an electric current is intended to flow. (NESC/PE) 599-1985w, C2-1997
(3) (machine winding) The element of a winding that comprises a group of series-connected coils. A single-phase winding or one phase of a polyphase winding may comprise one circuit or several circuits connected in parallel. (PE) [9]
(4) An interconnection of electrical elements. *See also:* network. (CAS) [13]
(5) (data transmission) A network providing one or more closed paths. (COM/PE) 455-1985r, 599-1985w
(6) In networking, a means of communication of electrical or electronic signals between two points. *Synonym:* network. *See also:* channel; dial-up circuit; foreign exchange circuit; four-wire circuit; leased circuit; simplex circuit; telecommunication circuit; two-wire circuit. (C) 610.7-1995
(7) (A) An arrangement of interconnected components that has at least one input and one output terminal, and whose purpose is to produce at the output terminals a signal that is a function of the signal at the input terminals. *Synonyms:* network; physical circuit. *See also:* channel; expansion board; telecommunication circuit. **(B)** An arrangement of interconnected electronic components that can perform specific functions upon application of proper voltages and signals. *See also:* integrated circuit; logic circuit. (C) 610.10-1994
(8) The physical medium on which signals are carried across the AUI for 10BASE-T or MII (for 100BASE-T). For 10BASE-T, the data and control circuits consist of an A circuit and a B circuit forming a balanced transmission system so that the signal carrier on the B circuit is the inverse of the signal carried on the A circuit. (C/LM) 802.3u-1995

circuit analyzer (multimeter) The combination in a single enclosure of a plurality of instruments or instrument circuits for use in measuring two or more electrical quantities in a circuit. *See also:* instrument. (EEC/PE) [119]

circuit, balanced *See:* balanced circuit.

circuit board A flat piece of insulating material, often multi-layered, constituted of epoxy-glass or phenolic resin, on which electrical components are mounted and interconnected by etched copper foil so patterned as to form a circuit. *Note:* Sometimes referred to as a "board" or a "card." *See also:* printed circuit board. (C) 610.10-1994

circuit bonding jumper The connection between portions of a conductor in a circuit to maintain required ampacity of the circuit. (NEC/NESC) [86]

circuit breaker (1) (general) (thyristor) A device designed to open and close a circuit by nonautomatic means, and to open the circuit automatically on a predetermined overload of current, without injury to itself when properly applied within its rating. *Note:* A circuit breaker is usually intended to operate infrequently, although some types are suitable for frequent operation. (IA/NESC) [86], 333-1980w, 428-1981w
(2) A switching device capable of making, carrying, and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents

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sending-end crossfire The crossfire in a telegraph channel from one or more adjacent telegraph channels transmitting from the end at which the crossfire is measured. *See also:* telegraphy. (EEC/PE) [119]

sending-end impedance (line) The ratio of an applied potential difference to the resultant current at the point where the potential difference is applied. The sending-end impedance of a line is synonymous with the driving-point impedance of the line. *Note:* For an infinite uniform line the sending-end impedance and the characteristic impedance are the same: and for an infinite periodic line the sending-end impedance and the iterative impedance are the same. *See also:* self-impedance; waveguide. (EEC/PE) [119]

send-only equipment Data communication channel equipment capable of transmitting signals, but not arranged to receive signals. (COM) [49]

sensation level *See:* level above threshold.

sense (navigation aids) The pointing direction of a vector representing some navigation parameter. (AE) 172-1983w

sense amplifier voltage window The minimum difference in threshold voltage required by a sense amplifier to differentiate between the low- and high-conductance MNOS thresholds for the two logic states. (ED) 641-1987w

sense and command features (nuclear power generating station) (power systems) (safety systems) The electrical and mechanical components and interconnections involved in generating those signals associated directly or indirectly with the safety functions; the scope of the sense and command features extends from the measured process variables to the execute features input terminals.
(PE) 308-1991, 379-1994, 603-1991

sense finder That portion of a direction-finder that permits determination of direction without 180-degree ambiguity. *See also:* radio receiver. (EEC/PE) [119]

sense of polarization For an elliptical or circularly polarized field vector, the sense of rotation of the extremity of the field vector when its origin is fixed. *Note:* When the plane of polarization is viewed from a specified side, if the extremity of the field vector rotates clockwise [counterclockwise] the sense is right-handed [left-handed]. For a plane wave, the plane of polarization shall be viewed looking in the direction of propagation. (AP) 145-1993

sense switch A switch found on the front panel or console of a computer. *Note:* The computer can be programmed to check a switch and to take some action depending on whether the switch is on or off. (C) 610.10-1994

SENSE/INT/SYNC-IN A special function signal from the BCC to the DCC in a BCC-to-DCC interconnection cable used for three purposes. The signal allows the DCC to sense if it has been physically connected to a BCC port, allows a BCC to send sync pulses to the DCC, and allows the BCC to send interrupt deactivate pulses to the DCC.
(EMB) 1073.3.1-1994, 1073.4.1-1994

SENSE/INT/SYNC-OUT A special function signal from the DCC to the BCC in a BCC-to-DCC interconnection cable used for three purposes. The signal allows the BCC port to sense if a DCC has been physically connected, allows a DCC to send sync pulses to the BCC, and allows the DCC to send interrupt activate and interrupt deactivate pulses to the BCC.
(EMB) 1073.3.1-1994, 1073.4.1-1994

sensibility, deflection (oscilloscopes) The number of trace widths per volt of input signal that can be simultaneously resolved anywhere within the quality area.
(IM) 311-1970w

sensing (navigation aids) The process of finding the sense, as, for example, in direction finding, the resolution of the 180° ambiguity in bearing indication; and, as in phase or amplitude-comparison systems such as ILS (instrument landing system) and VOR (very high-frequency omnidirectional range), the establishment of a relation between course displacement signal and the proper response in the control of the vehicle. (AE) 172-1983w

sensing circuit A circuit whose function is to detect the occurrence of some event at its input terminals.
(C) 610.10-1994

sensing coil (interferometric fiber optic gyro) A coil of optical fiber in which counter-propagating light waves differ in phase as a consequence of the Sagnac effect when the coil is rotated about an axis normal to the plane of the coil.
(AE) 528-1994

sensing element *See:* sensor; primary detector.

sensing station *See:* read station.

sensitive A condition of an object that allows it to accept input events. (C) 1295-1993

sensitive relay A relay that operates on comparatively low input power, commonly defined as 100 milliwatts or less. *See also:* relay. (EEC) [87]

sensitive volume (radiation counter tubes) That portion of the tube responding to specific radiation.
(ED/NPS) [45], 161-1971w, 309-1970r

sensitivity (1) (A) (general comment) Definitions of sensitivity fall into two contrasting categories. In some fields, sensitivity is the ratio of response to cause. Hence increasing sensitivity is denoted by a progressively larger number. In other fields, sensitivity is the ratio of cause to response. Hence increasing sensitivity is denoted by a progressively smaller number. *See also:* sensitivity coefficient. **(B) (electric pipe heating systems)** The ratio of the magnitude of a device response to the magnitude of the quantity measured. In electric pipe heating systems, sensitivity is usually associated with temperature controls and alarms and addresses their response function.
(PE) 622A-1984r

(2) (electric heat tracing systems) The ratio of the magnitude of a device response to the magnitude of the quantity measured. In electric heat tracing systems, sensitivity is usually associated with temperature controls and alarms and addresses their response function. (PE) 622B-1988r

(3) (monitoring radioactivity in effluents) The minimum amount of contaminant that can repeatedly be detected by an instrument. (NI/PE) 381-1977w, N42.18-1980r

(4) (measuring devices) The ratio of the magnitude of its response to the magnitude of the quantity measured. *Notes:* 1. It may be expressed directly in divisions per volt, millimeters per volt, milliradians per microampere, etc., or indirectly by stating a property from which sensitivity can be computed (for example, ohm per volt for a stated deflection. 2. In the case of mirror galvanometers it is customary to express sensitivity on the basis of a scale distance of 1 m.
(MIL) [2]

(5) (radio receiver or similar device) Taken as the minimum input signal required to produce a specified output signal having a specified signal-to-noise ratio. *Note:* This signal input may be expressed as power or as voltage, with input network impedance stipulated. (PE) 599-1985w

(6) (transmission lines, waveguides, and nuclear techniques) The least signal input capable of causing an output signal having desired characteristics. *See also:* ionizing radiation. (IM) [40]

(7) (camera tubes or phototubes) The quotient of output current by incident luminous flux at constant electrode voltages. *Notes:* 1. The term output current as here used does not include the dark current. 2. Since luminous sensitivity is not an absolute characteristic but depends on the special distribution of the incident flux, the term is commonly used to designate the sensitivity to light from a tungsten-filament lamp operating at a color temperature of 2870 kelvins. *See also:* phototube; sensitivity, cathode luminous.
(EEC/PE) [119]

(8) (A) (electrothermic unit) (dissipated power) The ratio of the dc output voltage of the electrothermic unit to the microwave power dissipated within the electrothermic unit at a prescribed frequency, power level, and temperature. **(B) (electrothermic unit)** (incident power) The ratio of the dc output voltage of the electrothermic unit to the microwave power

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